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The Engineer

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PUBLIC NOTICES

Tenders are Invited by the Director of Army Contracts for return on 6th August, 1930, for the PURCHASE of SURPLUS MACHINERY lying at the Royal Arsenal, Woolwich, including :—
CAPSTAN LATHES,
TURRET LATHES,
SCREWCUTTING LATHES,
MILLING MACHINES,
DRILLING MACHINES,
SHAPING MACHINES,
GRINDING MACHINES, &c. &c.
Tender forms with further particulars may be obtained on application to the DIRECTOR OF ARMY CONTRACTS, War Office (D.C. 4), Caxton House West, Tothill-street, London, S.W. 1. 5308

WIRING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 22nd July, 1930, for WIRING for ELECTRIC LIGHT, &c., at the National Physical Laboratory, Teddington, Middlesex.
Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5349

Wanted for the Indian ORDNANCE FACTORIES
TWO ASSISTANT WORKS MANAGERS.
(1) METAL and STEEL FACTORY, ISHAPORE (near Calcutta).
Applicants should possess a University Degree in Metallurgy, with special knowledge of the Non-ferrous Metals, or an equivalent diploma, and it is desirable that they should also have had at least three years' workshop experience in Brass Casting and Rolling, and/or Rod and Tube Drawing Shops, including experience in the control of labour in some post of authority.
(2) HARNESS and SADDLERY FACTORY, CAWNPORE.
Applicants should possess a University Degree in Engineering or an equivalent diploma, and, in addition, they should have had not less than three years' subsequent practical experience with a firm of Mechanical Engineers of good standing.
For both appointments applicants should be not less than 24 and preferably not more than 35 years of age.
The selected officers will be engaged for a period of five years, with the prospect of permanent retention thereafter. For officers of non-Asiatic domicile, pay will commence at the rate of Rs. 600 basic, plus £25 sterling overseas pay (in all about £70) per mensem. The appointments are non-pensionable, but subscription to a Provident Fund, to which Government also contributes, is compulsory. Free passages to and from India will be given on appointment and on termination of appointment and if the officers remain in the service after the first five years, leave passages to the United Kingdom will be granted.
The officers will be required to proceed to India in September next.
Intending applicants should write to the SECRETARY, Military Department, India Office, London, S.W. 1, for further particulars of the appointments and for a form of application, the latest date for the return of which will be the 19th July, 1930. All communications should be marked "Ordnance Recruitment." 5307

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POSTS :—
M/2015.—ASSISTANT ENGINEERS REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480 a year for the first three years; then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment and should preferably have attained the age of 22½ and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diplomas have been obtained without a College course should have had three years' practical experience of Civil Engineering under a qualified Civil Engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.
M/1895.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of KENYA COLONY for the Hydraulic Branch of the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising to £600 a year by annual increments of £20, and thence rising to £720 a year by annual increments of £30. Free quarters and passages and liberal leave on full salary. Candidates, age 25 to 35 years of age, must have passed Sections "A" and "B" of the examinations to qualify for the A.M.I.C.E. Diploma, or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Must have specialised in Hydraulic Engineering, both theoretical and practical, and should have had some experience in Hydrometric Work. Must be capable of computing the flows of rivers and streams, hydrographic surveys and inspections of the water resources of the Colony, and must be able to assist in the administration of the Water Law, the design of hydraulic structures, water supplies and drainage projects, &c.
Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 5351

APPLICATIONS are INVITED for the POSITION of SECTIONAL SUB-AGENT for Executive Work on a large Dock Contract in the Far East.
Give full details of previous experience, age, whether married or single, and when available.
Address, P19, The Engineer Office. P19 A

PUBLIC NOTICES

Air Ministry.
DIRECTORATE OF TECHNICAL DEVELOPMENT.
DRAUGHTSMEN REQUIRED at the Royal Aircraft Establishment, South Farnborough, as follows :—
REF. NOS. A. 413-20.—Two Draughtsmen, Grade III., for work in connection with Engines and Aircraft. Candidates should have had technical education approaching the standard of B.Sc. Degree and preferably some works experience.
REF. No. A. 433.—One Draughtsman, Grade III., for detail work in design of Wireless Equipment. Candidates should have had good technical education and appropriate works and drawing-office experience.
Salary 40s. to 52s. plus Civil Service bonus a week (present total equivalent £3 6s. 2d. to £4 2s.), commencing salary depending on experience.
Preference given, other things being equal, to ex-Service men.
Apply, quoting appropriate reference number, stating age and full particulars of training and experience to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 5353

Ministry of Health.
ENGINEERING INSPECTOR.
APPLICATIONS are INVITED by the Minister of Health for APPOINTMENT as ENGINEERING INSPECTOR.
The salary commences at £600 per annum and rises by yearly increments of £25 to a maximum of £1000. In addition to the salary a bonus, which varies with the Cost of Living, is payable. The bonus on the minimum salary is at present £176 7s.
The appointment will carry the usual Civil Service conditions as to pension, holidays, &c.
Candidates must be Chartered Civil Engineers having had wide experience in the Designing and Carrying Out of Works, especially Works of Sewerage and Sewage Disposal. Special consideration will be given to candidates with an Honours Degree in Engineering.
Preference will be given to candidates who served in His Majesty's Forces during the War.
The successful candidate will be required to devote whole time to the Public Service and must be prepared to take up duties without undue delay. The Headquarters of the Engineering Inspectors are in London.
Canvassing Members of Parliament or Officers of the Ministry will render a candidate liable to disqualification.
Forms of application, with further particulars of the appointment, may be obtained from—
THE DIRECTOR OF ESTABLISHMENTS,
Ministry of Health,
Whitehall, S.W. 1.
No application will be considered unless received on the prescribed form not later than the 21st July, 1930. 5309

PUBLIC NOTICES

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.
Principal :
B. MOUAT JONES, D.S.O., M.A. (Oxon).

UNIVERSITY OF MANCHESTER
(FACULTY OF TECHNOLOGY).
DEGREE COURSES IN TECHNOLOGY.
The Prospectus gives particulars of the courses leading to the Manchester University Degrees (B.Sc. Tech., M.Sc. Tech., and Ph.D.) and Certificates in the Faculty of Technology, in the following Departments :—
MECHANICAL ENGINEERING
(Prof. Dempster Smith, M.B.E., M.Sc. Tech., M.I.M.E.).
ELECTRICAL ENGINEERING
(Prof. Miles Walker, M.A., D.Sc., M.I.E.E.).
MUNICIPAL ENGINEERING
(G. S. Coleman, D.Sc. Eng., A.M. Inst. C.E., A.M. Inst. M. and Cy. E., F.R. San. I.).
APPLIED CHEMISTRY, including General Chemical Technology, Metallurgy and Assaying, Fermentation Processes (including Brewing), Electro-Chemistry, Photography, Colouring Matters, Foodstuffs and Fuels
(Prof. James Kenner, D.Sc., Ph.D., F.R.S.).
TEXTILE CHEMISTRY (Bleaching, Dyeing, Printing and Finishing), Paper Manufacture
(F. Scholefield, M.Sc., F.I.C.).
TEXTILE TECHNOLOGY
(Prof. W. E. Morton, M.Sc. Tech.).
INDUSTRIAL ADMINISTRATION (Post-Graduate Certificate Course)
(J. A. Bowie, M.A., D.Litt.).
Prospectus will be forwarded free on application to the REGISTRAR, College of Technology, Manchester. 5151

Heriot-Watt College, Edinburgh
DEPARTMENTS OF MECHANICAL ENGINEERING AND ELECTRICAL ENGINEERING.
MECHANICAL ENGINEERING :
PROFESSOR A. R. HORNE, O.B.E., B.Sc., M.I. Mech. E., A.M.I.C.E.
ELECTRICAL ENGINEERING :
PROFESSOR F. G. BAILY, M.A., M.I.E.E.
FULL-TIME DAY DIPLOMA COURSES leading to professional recognition.
CLASSES COMMENCE 14th OCTOBER.
Full particulars from the College.
J. CAMERON SMAIL, O.B.E., Principal. 5268

PUBLIC NOTICES

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, LONDON, E.C. 1.
FULL-TIME COURSES IN ENGINEERING are provided as follows :—
MECHANICAL,
CIVIL,
AERONAUTICAL,
ELECTRICAL AND
ELECTRICAL COMMUNICATION.
Students are able to qualify for the Polytechnic Diploma and (if Matriculated) the Engineering Degree of London University.
Entrance Examination, Wednesday, 16th July, 1930.
For prospectus apply to
5284 THE PRINCIPAL.

University of Liverpool.
FACULTY OF ENGINEERING.
DEAN : Professor G. E. SCHOLES, M.B.E., M.Sc., M.I.A.E., M.I. Mech. E.
Prospectus and full particulars may be obtained on application to the REGISTRAR of Courses designed for Students desiring to qualify as Mechanical, Electrical, Civil or Marine Engineers, as Naval Architects or as Metallurgists and Metallurgical Engineers. 4743

Indian Institute of Science, BANGALORE.
CHAIR OF ELECTRICAL TECHNOLOGY.
APPLICATIONS are INVITED for the PROFESSORSHIP of ELECTRICAL TECHNOLOGY in the Indian Institute of Science, Bangalore. Experience in teaching and research work an essential qualification.
Salary Rs. 1250-50-1500 per month, with an overseas allowance of Rs. 500 per month (together about £1500, rising to £1700 p.a.), free quarters, a retiring allowance of 10 per cent. of the total salary and an allowance towards first passage.
The appointment will be made for six years in the first instance.
Applications should be addressed to Dr. M. O. FORSTER, F.R.S., c/o Messrs. Jeremiah Lyon and Co., Ltd., 4, Corbet-court, London, E.C. 3, before 28th July. P7165

The University of Leeds.
DEPARTMENT OF AGRICULTURE.
APPLICATIONS are INVITED for the POSITION of ASSISTANT LECTURER (AGRICULTURAL ENGINEERING). A sound training in engineering essential. Salary £350.—Further particulars can be obtained from the REGISTRAR, The University, Leeds, by whom applications will be received up to 12th July, 1930. 5266

Administrative County of LONDON.
CONSTRUCTION OF A STORM-RELIEF SEWER.
The London County Council invites TENDERS for the CONSTRUCTION of a CAST IRON SEWER lined with concrete, 7ft. and 9ft. internal diameter, in tunnel and partly in compressed air, total length approximately 5180ft., from North End-road, Fulham, to the Council's pumping station in Lots-road, Chelsea, and including the construction of two weir chamber connections in open cut, all in the Boroughs of Fulham and Chelsea, in the Administrative County of London.
It will be a condition of the contract that the work must be actively commenced by 30th September, 1930, and the contractor must comply, as regards the employment of labour, with the terms and conditions laid down by the Unemployment Grants Committee.
The specification, bills of quantities, drawings and form of Tender may be obtained, on and after 7th July, 1930, on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £10 by cheque, draft or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender, and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.
Remittances by post should be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.
The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 11th August, 1930, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
MONTAGU H. COX,
5326 Clerk of the London County Council.

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For Advertisement Rates see Leader Page.

PUBLIC NOTICES

Bombay, Baroda and Central
INDIA RAILWAY CO.

The Directors are prepared to receive up to Noon on Monday, 21st July, TENDERS for the SUPPLY of STEEL MATERIAL (Angles, Channels, Flats, Plates, &c.).

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned). The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1.
30th June, 1930. 5324

Borough of Acton.
TO ENGINEERING CONTRACTORS.
SEWAGE PUMPING STATION.

The Town Council invites TENDERS from engineering contractors with experience in the construction of Sewage Pump Wells, Sumps, Engine-houses and Foundations, for the CONSTRUCTION of a NEW PUMPING STATION and other INCIDENTAL WORKS at the Sewage Pumping Works, Warple Way, Acton, W. 3.

Specification may be seen and quantities, form of Tender and other particulars obtained upon application to the Borough Engineer, W. G. Cross, Assoc. M. Inst. C.E., on payment of a deposit of £10, which will be returned on receipt of a bona fide Tender and the return of all loaned documents and plans.

Sealed Tenders, endorsed "Pumping Station," addressed to the undersigned, must be delivered on or before 3 p.m., 14th July, 1930.

The Council does not bind itself to accept the lowest or any Tender, and canvassing in any form is prohibited.

JOHN MORGAN.
Town Clerk.

Municipal Offices, Acton, W. 3.
21st June, 1930. 5260

Borough of Loughborough.
BOTTLE ACRE PUMPING STATION.

TENDERS are INVITED for CENTRIFUGAL PUMPING PLANT, including Electric Motors and Wiring complete, in accordance with the specification and other particulars, which may be obtained from the undersigned on the receipt of Two Guineas, which will be returned on the receipt of a bona fide Tender. Tenders are to be delivered to the undersigned not later than Monday, the 14th July, endorsed "Pumps."

The Corporation do not bind themselves to accept the lowest or any Tender.

W. GRANGER, A.M. Inst. C.E.,
Borough Surveyor.

Town Hall,
Loughborough.
26th June, 1930. 5316

Cornwall County Council.
TORPOINT FERRY.

The Cornwall County Council invites TENDERS for the CONSTRUCTION of a Large FLOATING BRIDGE propelled by Steam for use on its Ferry Service between Devon and Cornwall.

Copies of the drawings and specification and a form of Tender may be obtained from the undersigned on payment of Two Guineas, which will be returned on receipt of a bona fide Tender, and, if the Tender is not accepted, on the return of all papers and documents.

Tenders, endorsed "Floating Bridge," should be received by the undersigned not later than the 1st August, 1930.

The Council does not bind itself to accept the lowest or any Tender.

T. A. H. SHEERS,
Clerk of the County Council.

County Hall, Truro,
30th June, 1930. 5311

County Borough of Burnley.
GAS DEPARTMENT.

The Chairman and Members of the Gas Committee invite TENDERS from Gas Undertakings, Machinery Merchants, Metal Brokers, and others, for the SECOND-HAND GAS PLANT and MACHINERY, FIRE-BRICKS and STEELWORK, to be dismantled at their Parker-lane Gasworks now closed down.

Catalogues will be supplied on application to Mr. J. H. Clegg, M. Inst. Gas E., Gas Engineer, Gas Offices, Parker-lane, Burnley, Lancs.

The Tenders for the whole or any portion of this plant must be delivered to the Gas Offices, Parker-lane, Burnley, addressed to the Chairman of the Gas Committee on or before the first post on Thursday, 31st July, 1930, endorsed "Second-hand Plant."

COLIN CAMPBELL,
Town Clerk.

Town Hall, Burnley,
25th June, 1930 5328

Great Western Railway.
The Directors of this Company are prepared to receive TENDERS for the WIDENING of the MAIN LINE between Bentley Heath Level Crossing and Rowington Junction, near Birmingham.

Plans and specification, may be seen and forms of Tender and bills of quantities obtained at the office of the Engineer at Paddington Station, between the hours of 10 a.m. and 4 p.m., on payment of Two Guineas, which will be returned to bona fide tenderers.

Tenders, addressed to the undersigned and marked outside "Tender for Bentley Heath and Rowington Junction Widening," will be received not later than 10 a.m. on Thursday, the 17th July, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS, Secretary.

Paddington Station, London, 30th June, 1930. 5333

Great Western Railway.
The Directors of this Company are prepared to receive TENDERS for the CONSTRUCTION of TWO AVOIDING LINES at Westbury and Frome.

Plans and specification may be seen and forms of Tender and bills of quantities obtained at the office of the Engineer at Paddintgon Station, between the hours of 10 a.m. and 4 p.m., on payment of Two Guineas, which will be returned to bona fide tenderers.

Tenders, addressed to the undersigned and marked outside "Tender for Avoiding Lines, Westbury and Frome," will be received not later than 10 a.m. on Thursday, the 17th July, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS, Secretary.

Paddington Station, London, 30th June, 1930 5334

Metropolitan Water Board.
APPOINTMENT OF ASSISTANT ENGINEERING SUPERINTENDENT OF WORKS.

The Metropolitan Water Board invite APPLICATIONS from Resident Engineers, Civil Engineering Contractors' Agents and others in respect of the APPOINTMENT of an ASSISTANT ENGINEERING SUPERINTENDENT OF WORKS in the Chief Engineer's Department, at a salary of £350 per annum.

Applicants must have had experience in the control of workmen and in the laying of water mains and communication pipes in streets. The successful candidate will be required to devote his whole time to the service of the Board; to reside in either Brentford, Ealing or Twickenham, in which area the vacancy exists; to pass satisfactorily a medical examination by the Board's Chief Medical Officer; and to undertake in writing to join the Board's Superannuation and Provident Fund.

Applications, in the candidates' own handwriting, stating age and full particulars of education, training and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 21st July, 1930.

Canvassing will be held to be a disqualification.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
1st July, 1930. 5336

PUBLIC NOTICES

Durham County Water Board.
BURNHOPE RESERVOIR.
CONTRACT No. 6."

The Durham County Water Board invite TENDERS for VALVES, GAUGE PLATES and other ARTICLES required in connection with the Catchwaters.

Specification and form of Tender and copies of drawing may be obtained on application at the Office of the Joint Engineers, 34, Old Queen-street, Westminster, S.W. 1, on and after the 7th instant.

Tenders, endorsed "Durham County Water Board, Tender for Valves and Articles for Catchwaters," must be delivered at the Office of the Joint Engineers at or before Noon on the 21st instant.

The Water Board do not pledge themselves to accept the lowest or other Tender.

W. READ WARD,
Clerk.

July, 1930. 5350

Metropolitan Water Board.
APPOINTMENT OF DEPUTY CHIEF ENGINEER.

The Metropolitan Water Board invite APPLICATIONS for the APPOINTMENT of DEPUTY CHIEF ENGINEER at a commencing salary of £1200 per annum.

Applicants must be Corporate Members of the Institution of Civil Engineers, and must have had responsible experience with the Water Department of a Public Authority or with a Water Company.

Candidates must also have had considerable experience in the Design, Construction and Maintenance of important Waterworks, and in the general administration of large Waterworks Undertakings.

The successful applicant will be required to pass satisfactorily a medical examination by the Board's Chief Medical Officer, and to undertake in writing to join the Board's Superannuation and Provident Fund.

The appointment will be held during the pleasure of the Board.

Applications, stating age, and particulars of experience, education, training, qualifications and academical degrees, and accompanied by copies of three recent testimonials, should be addressed, in envelopes endorsed "Deputy Chief Engineer," to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the Offices of the Board not later than the 21st July, 1930.

Canvassing will be held to be a disqualification.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
28th June, 1930. 5312

Metropolitan Water Board.
APPOINTMENT OF DEPUTY PUMPING STATION FOREMAN.

The Metropolitan Water Board invite APPLICATIONS for the APPOINTMENT of a DEPUTY PUMPING STATION FOREMAN in the Chief Engineer's Department, at the commencing wages of £6 per week.

Applicants must have had considerable experience in the Erection and Working of Steam and Oil Engines and Pumps. The successful candidate will be required to devote his whole time to the service of the Board; to reside at Hampton (Middlesex), where the vacancy exists; to pass satisfactorily a medical examination by the Board's Chief Medical Officer; and to undertake in writing to join the Board's Superannuation and Provident Fund.

Applications, in the candidate's own handwriting, stating age and full particulars of training, qualifications and experience, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than 21st July, 1930.

Canvassing will be held to be a disqualification.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
2nd July, 1930. 5346

The Assam-Bengal Railway
COMPANY, LIMITED.
PRODUCTION ENGINEER.

REQUIRED, a PRODUCTION ENGINEER for the Locomotive and Carriage and Wagon Repair Shops of the above Railway Company in India. Age about 28 to 35 years.

QUALIFICATIONS.

(1) A sound knowledge of Modern Production Methods, with special training in Machine Shop Practice. Capable of introducing new production methods in large engineering works.
(2) Good Designer of Jigs and Tools and Fixtures, and able to make Tool Lay-outs for all classes of machine shop work.
(3) A sound knowledge of Planning and Rate-fixing. Capable of Laying out Detailed Manufacturing Operations, Estimating Times and Detailing the Types of Machines in which parts are to be manufactured.
(4) Must be prepared to Supervise Demonstrations of Operations on all classes of machine tools used in a large machine shop.
(5) A good knowledge of Inspection Methods and Gauging System essential.
(6) The candidate selected should have held the position of either production engineer, head planner and rate-fixer or machine shop manager in a large engineering works.
(7) Locomotive or Carriage and Wagon Experience essential.

SALARY.—Rs. 375 to 975 per calendar month (plus overseas allowance), according to age and qualifications.

TERMS.—A three years' agreement in the first instance, and first-class free passage to India. The selected candidate will be required to pass a strict medical examination.

Particulars of candidates' careers, giving in chronological order (with dates) details of general and technical education, where apprenticeship or pupilage was served, and subsequent experience, and stating age and whether married or single, accompanied by copies only of testimonials, should be addressed to the undersigned. Applications will be considered as received.

By Order of the Board,
THOS. C. BRETT,
Secretary.

30th June, 1930.
Bishopsgate House,
80, Bishopsgate, E.C. 2. 5327

LONDON REPRESENTATION.
ENGINEERING FIRMS in the Midlands and North of England are invited by advertiser, an old-established Company with an excellent connection and reputation in the Engineering World, to give consideration to the question of the heavy expenses necessary for the maintenance of their LONDON OFFICE. The idea is that by co-operation definite economies can be made possible without impairing Efficiency and Turnover, and a firm accepting the suggestions which will be offered cannot fail to benefit thereby.

Those interested please address P27, The Engineer Office. P27

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a YOUNG ENGINEER to Undertake Sales Development of special Electrical Apparatus, particularly among municipal and county authorities, as a preliminary to an executive position with old-established Midland firm; shop and drawing-office experience essential; electrical knowledge an advantage.—Address, 5339, The Engineer Office. 5339 A

WANTED, CIVIL ENGINEERING ASSISTANT in a Municipal Engineer's Office near London, with sound knowledge of Road Bridge Construction and Retaining Walls. Appointment two years certain to satisfactory man. Salary £350 per annum.—Address, 5338, The Engineer Office. 5338 A

SITUATIONS OPEN (continued)

WANTED, FIRST-CLASS AGENT for Large Railway Construction Contract in South America. Previous experience in this capacity essential and to be thoroughly conversant with language. State experience, age, and salary required.—Address, P7185, The Engineer Office. P7185 A

WANTED IMMEDIATELY, THREE Energetic YOUNG MEN, age about 26, good education and training essential, to Assist in Works Production in an Engineering Shop in the Midlands.—Address, 5352, The Engineer Office. 5352 A

ELECTRICAL ENGINEER (Single, age 30/35 Years), for India. Practical and Theoretical Training. Experience in Power Station and Colliery Electrical Plant (both Surface and Underground)—Write, with full particulars and references to "X. H.," c/o Charles Barker and Sons, Ltd., 31, Budge-row, E.C. 4. 5314 A

(1) ENGINEER DESIGNER REQUIRED, experienced High Pressure Centrifugal Pumps. Reply with photo, giving full details, which will be treated in strict confidence.

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EXPERIENCE: Chief Engineer, General Manager, Director, railways, marine and other transport, engineering works, factories, shipyard, commercial and industrial undertakings. Successful with labour.

ATTAINMENTS: Positions of trust and responsibility, self-confidence, ABILITY TO TURN A LOSS INTO PROFIT, respect and confidence of employers and subordinates, substantial remuneration, creditable references.

REQUIRES: RESPONSIBLE EMPLOYMENT, home or abroad, irrespective of difficulties or climate.
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For continuation of Small Advertisements see page 4.

JULY 4, 1930.—VOL. CL.

THE ENGINEER.

A Seven-Day Journal

The Channel Tunnel.

ON Monday last, June 30th, there was an open debate in the House of Commons on the resolution proposed by Mr. E. Thurtle to the effect that since a Channel tunnel could be constructed by private enterprise without any financial assistance from the State and since the Channel Tunnel Committee had reported its construction to be of definite advantage to the country, also, in view of the fact that such a tunnel, in addition to providing immediate employment, would be of great advantage to British trade and industry in future years by affording better transport between this country and the Continent, every facility should be given for the project to be undertaken at the earliest possible opportunity. The resolution was seconded by Sir Basil Peto, who spoke for the project. The Prime Minister summarised the position as the Government saw it when it came to the conclusion embodied in the White Paper, and said that the case for the tunnel had not been proved from either the point of view of trade, of passenger convenience, or of engineering practicability. The tunnel remained a project. Very few men would find employment by its construction and many might be discharged in other industries were it to be built. Mr. MacDonald briefly considered the military point of view and closed by stating that there appeared to him to be no reason for the Government to reverse the policy pursued by successive Governments for nearly 50 years with regard to the proposal. After several speakers had given their opinion on one side and on the other the resolution was put to the open vote. One hundred and seventy-two Members supported the resolution, and one hundred and seventy-nine voted against it, so that it was lost by the small majority of seven.

Charing Cross Bridge.

AT a meeting of the London County Council, held on Tuesday last, July 1st, the composition of the Advisory Committee for the Charing Cross bridge scheme, which was proposed by the London County Council Improvements Committee, was announced. The chairman of the new Committee, which will be entrusted with the task of preparing and submitting to the Council within nine months an agreed scheme for a road bridge and approaches at Charing Cross is to be Sir Leslie Scott, K.C., who will be assisted by a vice-chairman, yet to be appointed. Representatives have been nominated by the London County Council, the Westminster City Council, the Lambeth Metropolitan Borough Council, the Southern Railway Company, the Underground Railway Company, the Port of London Authority and the Institution of Civil Engineers. Other institutions and authorities which will be represented include the Royal Academy, the Royal Institute of British Architects, the Town Planning Institute, the Surveyors' Institution and the Royal Fine Art Commission. Although he was invited to send representatives, the Minister of Transport will not be represented, as it is his wish to be entirely free to examine the report on its merits and from the financial point of view. All the members of the Committee will act in an honorary capacity and much of the technical work will be dealt with by sub-committees.

The National Physical Laboratory.

ON Friday last a very large party of visitors inspected the numerous departments of the National Physical Laboratory, Teddington, on the invitation of the President of the Royal Society, Chairman of the General Board of the Laboratory. The guests were received in the Main Aerodynamics Building by Sir Ernest Rutherford, Sir Richard Glazebrook and Sir Joseph Petavel. Whilst much of interest was to be found in all the departments, we may refer specially to the model of the pressure wind-tunnel and to the high-voltage research laboratory. The model is about 2ft. 6in. in external diameter and part is cut away to show the interior arrangements. The steel chamber illustrated in our issue of June 20th will form an outer case. Within it there will be an inner tube fitted at one end with a grid for smoothing the air flow and at the other with a fan consuming nearly 600 H.P. for circulating highly compressed air. The aeroplane model will be suspended in the centre of the inner chamber and all the measurements will be recorded electrically, nothing but a few wires passing out through the tunnel. A special electric balance has been designed for the purpose and the calibration of the Pitot tubes at slow speeds is being carried out on a whirling arm. The main equipment in the high-voltage research building comprises three transformers and generating plant. The transformers are rated at 375 kilovolts each and can be used singly, in parallel, or three-phase, and for the highest voltage—about 1000 kilovolts—are coupled in cascade. The condenser method is employed for determining the peak voltage The condenser consists of an upper sphere, 1 m. in diameter, and the central portion of a lower hemisphere. During the afternoon frequent demonstrations of the flash-over on a string of insulators, both in the dry and under rain conditions, were made just outside the building.

Empire Broadcasting.

A FEW days ago Lord Passfield, Secretary of State for the Colonies, opened the fourth plenary session of the Colonial Office Conference. One of the subjects under discussion was Empire broadcasting and in dealing with this matter Lord Passfield referred to the benefits that would accrue to the Colonies if they could be included within the excellent system of the British Broadcasting Corporation. It would not only be an additional link binding the Empire together, but it would be particularly acceptable to the lonely listeners in the more distant Colonies. Reviewing the history of the Corporation's activities in Empire broadcasting, Sir John Reith referred to the work of the experimental station at Chelmsford, which broadcasts, regularly, portions of the 5 XX programme for the benefit of the Colonies. The transmissions from Chelmsford should not, he said, be regarded as all that could be done by a regular, organised service, for, if a high-power short-wave station could be established, an efficient broadcast service to the Colonies would be possible. The B.B.C. had no commercial motive in the matter. Whatever there might be of benefit in the British system, British work and prestige would be available, free of charge, to the Colonies, provided that the actual out-of-pocket expenses involved in organising an Empire service could be met from some source. If it were possible to organise an Empire service, it would also be of value to the Dominions through the existing stations capable of receiving transmissions. Representatives of the Colonies who took part in the discussion were unanimous in the view that a broadcasting service to the Colonies would be of inestimable value.

The Royal Air Force Display.

THE eleventh Royal Air Force display, held at Hendon last Saturday, proved once again that the public in large numbers takes a very lively and educated interest in aeronautics. Some of the events, such as the acrobatics of nine machines tied together in groups of three by elastic cords, were purely of a display kind, but by far the greater number of the performances which interested and thrilled the spectators, were in the nature of ordinary service manœuvres, or were such as had a direct application to service conditions. The parade and flight of new and experimental types of machines provided the chief technical interest of the display. We were particularly struck with the performance of the new interceptor fighters—the Fairey "Firefly," the de Havilland-Napier and the Bristol "Bullpup." These machines, designed to take off and attack an enemy flying at a high altitude, the first sight of the enemy being obtained when he is directly over the point of take off, are distinguished by their extraordinary climbing ability combined with a high speed at altitude. They showed themselves on Saturday to be capable of practically pulling themselves upwards by their screws. From another point of view we were greatly interested in the simultaneous taking off and manœuvring of the tailless "Pterodactyl," the Cierva "Autogiro" windmill plane, and the Handley Page slotted-wing "Gugnunc" biplane, the machine which was entered for the recent Guggenheim safe aeroplane competition. These three machines represent three separate and very distinct attempts to improve the safety of the aeroplane. The difference in their performance was noticeably slight. Certainly, the "Gugnunc" rivalled the "Autogiro" in the steepness of its path when taking off and alighting. The three machines flew in formation with remarkable regularity. It was, however, noticed that the "Pterodactyl" seemed to suffer more than the others from the marked "bumpiness" of the air.

An Important Engineering Amalgamation.

A WORKING arrangement which will, it is expected, have far-reaching effects, has been entered into by Ruston and Hornsby, Ltd., of Lincoln, Grantham and Stockport, and R. A. Lister and Co., Ltd., of Dursley, Gloucestershire, in order to secure efficient co-ordination in the design and production and sales of the products of the two firms. The arrangement will not involve the merging of the financial interests of the two firms, but it will effect twelve different subsidiary and associated companies with interests in Australia, Canada, the United States, France, Belgium, Germany and the Argentine. The financial, manufacturing and selling resources of the individual firms will be utilised to secure a substantially greater share of the overseas trade for British engineering products, and arrangements have been made for a considerable expansion in their production programmes. Further extensions are to be made at Dursley, and under the new arrangement R. A. Lister and Co., Ltd., will concentrate on engines up to 25 horse-power. Ruston-Hornsby will, on the other hand, continue the manufacture of their gas and oil engines, while a new light, high-speed, cold-starting oil engine for powers between 25 and 100 B.H.P. will be produced jointly by the two firms.

The British Broadcasting Corporation's Third Report.

THE third annual report of the British Broadcasting Corporation, covering the year 1929, shows that the development of broadcasting has been rapid and there are no signs of retrogression. Although at one time it appeared likely that a saturation point in the number of licences would soon be reached, present statistics indicate that those apprehensions were groundless. At December 31st, 1928, the number of licences issued was 2,628,392, and at December, 1929, 2,956,736, an increase of 328,344. These figures include the licences issued free to the blind, which increased from 14,068 to 15,964. The total increase during 1928 was 233,218. The average breakdown per station, with 66,435 total programme hours, was 0·05 per cent., which, owing mainly to a fire at Bradford, was slightly higher than the previous year. The London regional station was ready for technical tests in August and public experimental tests on a double programme basis started on December 9th. Constructional work began on the North regional station at Slaithwaite, near Huddersfield, but owing to the exposed nature of the site and severity of the weather, only moderate progress was made. For the Scottish regional scheme several sites were considered in the neighbourhood of Falkirk and investigations were put in hand to determine the most suitable. The permanent receiving station at Tatsfield for frequency checking and relaying by wireless was completed and put into service on August 8th. Several relays from America were carried out *vid* the experimental station at Terling, which had been specially equipped for the reception of short wave transmissions. Programmes were also relayed by telephone cable lines from Belgium and Germany. A considerable amount of original work was done on the design of efficient aerials and transmitters, particularly in connection with the equipment of new stations. Further valuable data have been obtained on the attenuation of waves having frequencies within the bands allotted to broadcasting.

X-Ray Crystal Analysis in Engineering.

By V. E. PULLIN, Director of Radiological Research, Research Department, Woolwich.

IT was not for many years after the discovery of X-rays that their nature was understood and they were identified with ordinary light. This development came about as a result of a brilliant piece of mathematical analysis by Professor von Laue in 1912. von Laue's prediction was that if X-rays had the same nature as light, but of infinitely shorter wave length, their diffraction should be possible if a suitable—*i.e.*, fine enough—diffraction grating could be found. He suggested that a crystal, because of the regularity of its structure and the distance apart of its constituent atoms, would function perfectly in this respect as a three-dimensional transmission grating. Friedrich and Knipping carried out experimental work on these lines with conspicuous success, and the identity of X-rays as an electro-magnetic phenomenon was put beyond all doubt.

This discovery, quite apart from its theoretical and historic interest, was destined to add enormously to the practical value of X-rays in quite a new and hitherto unsuspected field of work.

The fine structure of materials must obviously exert a very great influence on their physical properties. By fine structure is meant something very much smaller than anything capable of detection by a microscope, and for this reason something which, prior to von Laue's discovery in 1912, had proved impossible of direct investigation. In this connection there are two highly important facts which render X-ray crystal analysis of paramount importance to engineers. First of all, metals and most engineering materials are crystalline, and, secondly, the working of metals, either by tools or heat, always tends to alter or modify the crystal structure. It is the business of X-rays in this connection to provide us with pictures or diagrams from which we may, if we have the necessary knowledge, deduce the manner in which individual atoms are normally arranged, and how they are modified by mechanical or heat treatment or by alloying with other elements. The next operation is the interpretation of the X-ray story in terms of mechanical properties.

The physicist who concerns himself with X-ray analysis has really progressed quite a long way in the art of obtaining and interpreting X-ray spectra, but he is very often in considerable difficulty when he seeks to apply his results in practice. For this reason much closer collaboration is desirable between the X-ray worker and the engineer. X-ray crystal analysis is a very highly technical subject, and it is idle to suppose that it can ever reach a stage where it may be used as readily by the engineer, as, for example, the microscope. Nevertheless, a working knowledge of the subject and its limitations can be, and should be, acquired by every engineer. It is fundamental to his subject.

It is the purpose of this article to explain in general terms what crystal analysis depends upon and how it is done; and also to show from some typical spectra how their interpretation is important in general engineering practice. No attempt will be made to discuss the many applications of the subject in other spheres of activity.

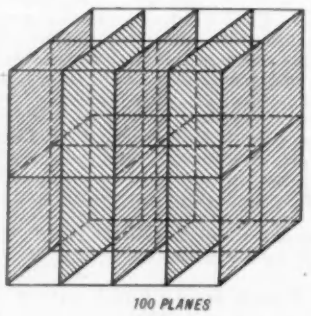
In the first place, it may be said that any crystalline material is suitable for investigation by X-ray spectrum analysis—most substances and all metals are therefore suitable. The next point for consideration is the character of a crystal and why it is that so much information may be derived from its analysis. A crystalline substance is one characterised by the regular arrangement of its structural units. According to the material of the crystal, these units, which may be atoms or groups of atoms, are arranged in a perfectly definite pattern which is repeated over and over again in three directions. Crystals grow, and by their growth is meant that this identical pattern of units reproduces itself again and again along the three axes of the structure. A crystal, then, is simply a regular arrangement of structural units. If we could see inside and through it, which is impossible, we should find a beautiful and symmetrical honeycomb structure or lattice, presenting exactly the same appearance from any point on the lattice.

There are many different kinds of crystals, and they have been classified according to their external features into some thirty-two classes, of which only three types are of immediate importance to the engineer. They are called (1) face-centred cubic crystals, (2) body-centred cubic crystals, and (3) hexagonal crystals. To the first group belong metals which are ductile, such as copper, aluminium, silver, gold, lead, nickel, and that variety of iron known as the γ (gamma) type. To the second group belong α (alpha) iron and the brittle metals, such as molybdenum, tungsten, chromium, and so on; and to the third group belong zinc, osmium, and some few others. A crystal lattice of the first type is cubic, having an atom at each corner—which, of course, it shares with adjacent cubes—and one in the centre of each face; each crystal unit cell will therefore contain four atoms. The second type has an atom at each corner and one in the centre of the cube; each crystal unit cell will therefore contain two atoms. The third consists of two simple hexagonal lattices, combined so that each cell contains two atoms. The atoms in a crystal unit cell are separated from each other by about an X-ray wave length; in other words, the length of any side of such a cell is of the order of one Angstrom unit (an Angstrom unit is one hundred millionth of a centimetre).

A reference to Figs. 1, 2, 3 will show that we may draw various series of planes through such lattices as I have described. Crystallographers for convenience name these planes with reference to the three axes of the cube, for example, in Fig. 4, O X, O Y, and O Z are the three axes of the cube, and the planes in our illustrations are named in so far as they cut any of these axes. Thus, the plane A, B, C—Fig. 4—cuts each axis once; therefore it is called the (111) plane. The planes shown in Fig. 1 cut the O X axis only, and are therefore called (100) planes. The planes in Fig. 3 cut the O X and the O Y axes and are called (110) planes, and so on.

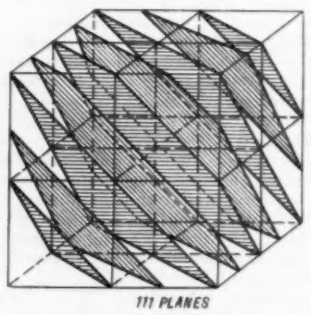
For the purpose we have in view—that is, that the engineer shall understand something of this field of work and the nature of the information yielded by this new method of investigation—it is not necessary to explain very much about crystal systems, but it is necessary that he should know that it is these symmetrical lattice planes, which obviously exist in all directions in a uniform atom lattice, that are instrumental in producing the X-ray diffraction phenomena with which we are concerned. The spots, rings and lines which we shall find in X-ray spectra depend entirely for their position and intensity upon the disposition of these crystal planes. There will be one particular pattern for a face-centred crystal, another for a body-centred crystal, and so on. Such then is roughly, the internal structure of a crystal.

The first business of crystal analysis is to show what this structural unit arrangement is and to give information which allows us to calculate the dimensions and the shape of the crystal units. Single crystals, as everyone knows, may sometimes be seen by the naked eye and sometimes only by the aid of a microscope, but we can never hope to see a crystal structural unit by any method; it is too small.



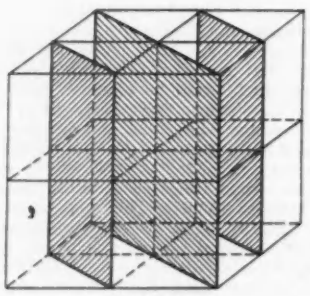
100 PLANES

FIG. 1



111 PLANES

FIG. 2



110 PLANES

"THE ENGINEER" FIG. 3

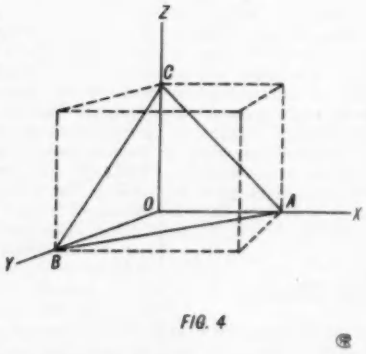


FIG. 4

FIGS. 1 TO 4—CRYSTAL LATTICES

Now we must return for a moment to von Laue's discovery of the diffraction of X-rays by a crystal lattice. Experimentally, this meant that when a beam of X-rays was passed through a crystal, the component parts of the beam were deflected by the regular atom planes within, and, therefore, if a photographic plate were placed so as to catch and record the emergent beam it would show not only a central spot due to the main beam, but also a symmetrical arrangement of small spots surrounding the centre spot and at varying distances from it, due to the components that are deflected by the atom planes.

von Laue's prediction was correctly based upon the assumption that X-rays were a form of light having a definite wave-length. Very soon after the experiments of Friedrich and Knipping, two English physicists, Sir William Bragg and his son, Professor W. L. Bragg, enunciated the idea that X-rays would, in a similar way, be reflected by the regular atom planes in a crystal. By the word reflection, however, we are not to understand the same phenomenon as the reflection of ordinary light by a mirror, because X-ray reflection does not take place at the surface of a crystal, but from the regularly spaced atom planes inside it. X-ray reflection really involves this assumption—that a train of X-ray waves, of appropriate wave length impinging upon an electron, set it into forced vibration and thereupon cause it to emit a train of waves having the same frequency as the exciting train. The theoretical consideration, however, does not matter very much for our purpose. The phenomenon we are discussing may be regarded as that of reflection which, under the correct circumstances, is reinforced in intensity by the succeeding parallel atom layers beneath the crystal surface. What Professor Bragg did, which was of so much importance to practical crystal analysis—in fact, made it possible—was to show that a definite relation exists between the wave length of the X-ray beam, the distance apart of the atom planes—this, of course, gives the clue to the dimensions and shape of the crystal unit—and the incident angle which the X-ray beam makes with the reflecting plane or planes.

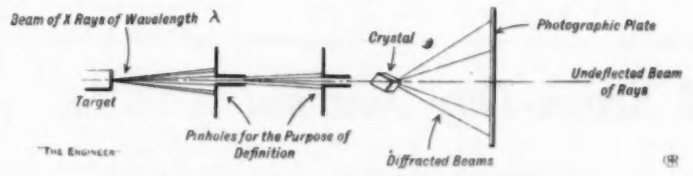


FIG. 5—DIFFRACTION OF X-RAYS IN A CRYSTAL

If we examine a crystal of which the atomic spacing is unknown, we may find it by means of the Bragg equation—$n\lambda = 2d \sin\theta$, where λ is the wave length of the X-rays, d is the distance separating the atom planes and θ is the glancing angle.

It is very easy to arrange the experimental conditions so that the wave length λ of the X-rays is known. It will be seen from Fig. 5 how the angle through which the X-rays are bent may be measured, and from a knowledge of these two factors we may calculate the spacing of the atom planes responsible for each deflected ray which gives rise to a spot on the photographic plate. It is very important to notice that the conditions expressed in the Bragg equation must be fulfilled before any reflected spot can appear on the plate. In other words, the atom planes must make precisely the correct angle with the particular incident wave length before reflection can occur.

Now let us see how this vitally important principle may be employed in the various practical aspects of engineering.

The chief things of importance that may be learnt by the engineer from the crystal analysis of his materials are:—The size of the crystals, the manner in which the crystal units are oriented, the effect on the crystal lattice of adding small quantities of foreign materials, such as carbon in iron to produce steel, the effect of cold work and annealing on the crystal units, and how far strain in a metal may be detected by X-rays. Considerable work has been done on all these questions, and we shall now see what sort of results the X-ray analysis can be made to yield.

There are many different methods of technique in the application of X-ray crystal analysis, but they all depend upon the fundamental principle just explained. It is, however, very important that the most suitable method should be chosen for each particular problem. If we consider a single crystal and an incident beam of X-rays made up of several different wave lengths, every set of planes which makes the correct angle with any of the component waves in the beam of X-rays will produce a spot on the photographic plate, and a multitude of spots would therefore indicate a large number of participating crystal planes. Further, the arrangement or symmetry of the spots affords a guide to the crystal form. Sometimes it is not possible to obtain our specimen in the form of a single crystal, and we have to be content with a small piece of metal containing a large number of crystals. If this is the case there is a choice of method depending upon the information we wish to acquire. We may, for example, grind up our specimen into a fine powder and put it into a small

thin-walled glass tube. We shall then have, in such complete disorder, a mass of crystal planes presenting every possible angle to the incident beam. This technique is due to two independent investigators—Hull, and Debye and Scherrer. In this method it is customary to pass an X-ray beam of one particular wave length through a system of, say, two fine line slits for the purpose of obtaining sharp definition before allowing it to fall upon the specimen. A strip of film is arranged in a circle around the specimen on the emergent side, and the results are seen as a series of lines on the film at varying distances from the zero. By applying the Bragg equation we shall find that each line corresponds to one particular set of planes, and we may thus detect any abnormality or distortion in their spacing by a comparison of the results with what is known to be the normal spectrum of the specimen. This method has value in cases where we wish to detect any lattice distortion due, perhaps, to the presence of a foreign element.

We may, on the other hand, use our metal fragment just as it is and reflect the X-rays from it. The method is essentially the same as the previous one and the atomic plane spacing may be calculated in the same way. Care must be observed in preparing the face of the specimen to avoid introducing local lattice distortion by cutting or rough treatment. It is also highly important to remember that the examination of the planes just below the surface may be very misleading and the results by no means true of the material as a whole. X-ray spectra obtained by the reflection method have very valuable applications, but the method is by no means of universal application.

Another method which has very great value in the examination of metals is a modification of the original procedure due to von Laue. A very penetrating X-ray beam is employed, made up of a large number of wave lengths, and the rays, after having been defined by a small pin-hole aperture in the apparatus, fall upon and penetrate the specimen. This usually takes the form of a solid metal plate about one hundredth of an inch in thickness. Here we have a condition exactly the same as in the powder method in that the specimen consists of a large number of crystals having a perfectly random arrangement. Consequently, there will be sets of reflecting planes suitably placed at every conceivable angle. A photographic plate or film is mounted on the emergent side of the specimen.

The information which may be acquired by these pictures is diverse and very valuable. We may determine the crystal size of the material, we may deduce the crystal structure, and we may derive information concerning the orientation of the crystal units which may indicate cold working or strain. The anaylsis, if carried out subsequent to annealing, will yield important information as to partial or complete removal of orientation or strain, and also show the point at which recrystallisation occurs. Fig. 7 illustrates the apparatus used for this method of analysis in the Research Department, Woolwich. It is so arranged that six spectra may be obtained simultaneously. The X-ray tube is inside the cylindrical box which is of lead protective material, and the little cameras are seen ranged around the circumference.

Characteristic diagrams obtained by this method are reproduced in a Plate Supplement. They are concentric circles in some cases—Fig. 13—and spokes in others. Sometimes the spokes are not very symmetrical, as in Fig. 14, and sometimes they have a highly symmetrical appearance, as in Fig. 15. In other cases there are no rings, but only a conglomeration of spots. Then, again, in some instances the rings are clear and well defined, and in others they present a somewhat hazy appearance. All these pictures have different meanings, which we will now describe.

Fig. 13 is the effect produced when the specimen

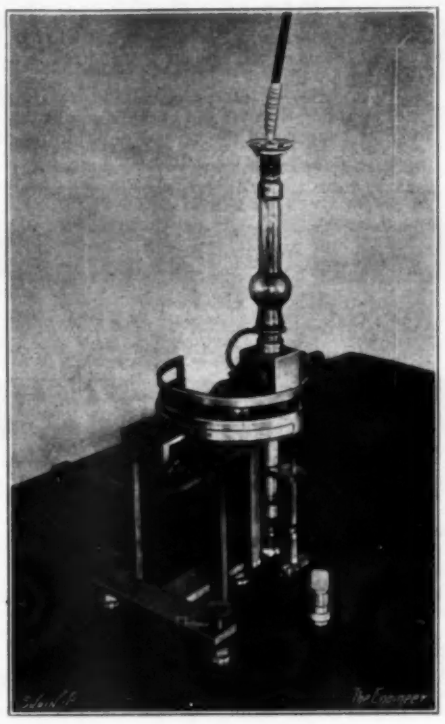


FIG. 6—X-RAY SPECTROMETER

consists of a mass of small crystals with no preferential orientation at all. Here each ring is referable to a particular plane in the crystal which may always be identified.

Fig. 16 is the effect produced by a specimen still with its crystal units unoriented, but having much larger crystals.

Fig. 17 is typical of a specimen having very large crystals. The rings have entirely disappeared, and each crystal independently reflects the X-rays to a spot. There is no preferred orientation.

Fig. 14. This picture is quite different. Here we have some suggestion of rings indicating fairly small crystals, but there is an appearance of spokiness, or, as it is technically called, asterism. This appearance is thought to indicate that the crystals are in a state of strain—it shows itself when a metal test piece is pulled in a tensile testing machine, as we shall see later on. It indicates a tendency for the crystal units to orient themselves in a definite direction. This asterism would disappear if the specimen were thoroughly annealed.

Fig. 15 illustrates preferred orientation of crystal units. It will be noticed that it is a perfectly well-defined and symmetrical pattern. It is, in fact, the characteristic pattern due to the preferred orientation, viewed perpendicularly to the direction of rolling, of a metal having a face-centred cubic lattice. The actual specimen in this case was copper.

Fig. 18 is another specimen which has also been rolled and therefore exhibits preferred orientation. Although it is equally well defined, it will be noticed that the pattern is different; this is because they are different crystals. In this case it is a body-centred cubic lattice. The specimen was α iron.

Fig. 19 is the same specimen as Fig. 17; after having been strained, the crystals have been elongated similar to those in Fig. 14.

These few examples will illustrate the sort of information that can be obtained from the X-ray crystal analysis of metals. It would be possible to quote many other examples, but we will content ourselves with a few more illustrations showing the results obtained in some practical investigations. As I said in the beginning of this article, my chief desire is to convey to the engineer a working familiarity with the results of this new method of investigation. For this reason the physical aspect of the subject has been neglected in order that more emphasis might be laid upon the character of the information he is likely to acquire. The technique and its development may be left to the physicist who at the present moment is devoting both skill and time to this work, but if it is to be quickly fruitful, the engineer must understand what is being "got at" in order that he may take cognisance of the subject and participate in the interpretation of results from the point of view of the development of his own research.

Questions concerned with carbide in steel, the crystal structure of alloys generally and particularly the brasses; the effect of the alloy elements in modern complicated steels; the differences between good and bad transformer iron, and the structure and properties of electro-deposited metals, all are suitable subjects for X-ray spectra investigation.

My first series of examples are concerned with iron. The specimen was progressively rolled and X-ray spectra were obtained at various stages of the rolling process. Fig. 20 is a spectrogram of the original specimen. It shows that the iron had moderately large crystals without any orientation whatever. After rolling to 90 per cent. of its thickness, a small specimen was cut and X-ray spectra were obtained in three directions:—(1) By passing the X-rays through it in a direction perpendicular to the direction of rolling—this is the N (normal) spectrogram, Fig. 21. (2) By passing the X-rays through in a direction parallel to the direction of rolling P (parallel), Fig. 21. (3) By passing the X-rays through at right angles to the direction of rolling T (transverse), Fig. 21. It will be observed that these pictures differ considerably from Fig. 20. Some suggestion of rings make their appearance, indicating that the rolling process is beginning to break up the crystals. Further, a general spokiness appears. This indicates a strained condition in the crystals. All three views yield approximately the same pictures.

The specimen was then rolled to 60 per cent. of its thickness and three similar spectrograms obtained

FIG. 7—APPARATUS FOR CRYSTAL ANALYSIS

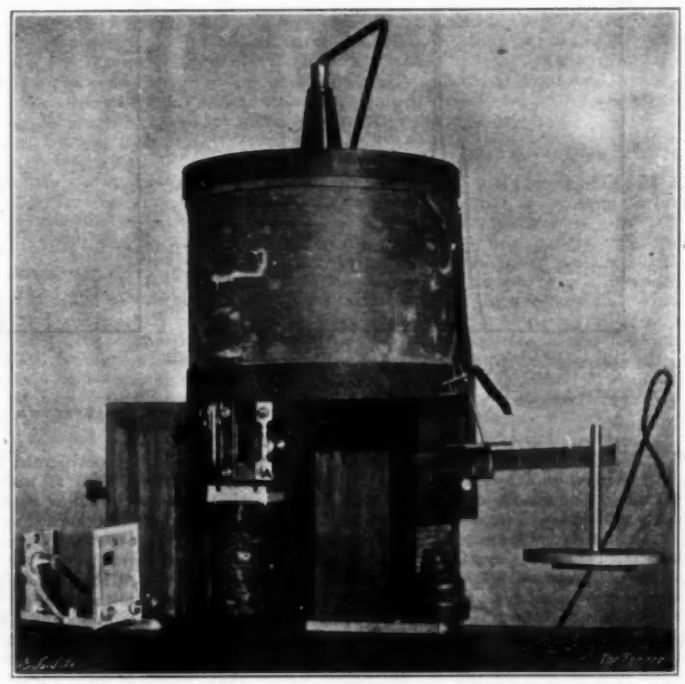


FIG. 8—APPARATUS FOR STRAIN EXAMINATION

—Fig. 22. We now see a further change making its appearance. The rings are more clearly defined, hence the crystals are much smaller and the general spokiness is beginning to resolve itself into clumps. In the T spectrogram it will be observed that a definite orientation pattern is present. This particular pattern is characteristic of α iron. It is a very curious thing that when iron is rolled, preferential orientation, as indicated by this characteristic pattern, first appears in a direction viewed at right angles to the direction of rolling. The specimen was then rolled to 5 per cent. of its thickness and three more spectra obtained—Fig. 23. Here, again, the appearance is different. The crystals are now very small and preferential orientation is apparent in each direction. The rolling has induced the crystal units to take up a definite and oriented position. It is probable that this fully orientated condition is accompanied by a relief of strain which existed in the first two sets of pictures. Having rolled the specimen to 5 per cent. of its thickness, we will now observe the effect of heat treatment on a reverse series of spectrograms. Fig. 24 shows the three spectra obtained after annealing the specimen for half an hour at 450 deg. Cent.; it will be observed that no change whatever has taken place. The crystals are still small and the full orientation is present. Fig. 25 shows spectrograms obtained after annealing at 500 deg. Cent.; this marks a change point. The general fuzziness of the rings indicates that recrystallisation is occurring, and the orientation tends to disappear except in the direction at right angles to direction of rolling—Fig. 26. These were obtained after annealing at 850 deg. Cent. Recrystallisation is now very marked, and the preferential orientation has almost disappeared in the "N" and "P" views, although it is still very strong in the "T" view—Fig. 27. After annealing at 1050 deg. Cent. all the pictures now indicate very large crystals, and the orientation is absent except for a small suggestion in the "T" view, where the crystals exhibit a suggestion of a strained condition. These pictures suggest that until the temperature of 1050 deg. Cent. was reached, the annealing process was insufficient to remove the orientation from this specimen. A point worthy of notice is that it is in the transverse direction that orientation of the crystallites first makes its appearance, and it is retained in the same direction after it has disappeared in the other two. This series also indicates that this particular method of analysis affords a very sensitive method of determining the effect of heat treatment.

The next series refers to a specimen of manganese steel—face-centred cubic lattice. Fig. 28 are the three spectra obtained after rolling. Fig. 29 after annealing for half an hour at 600 deg. Cent. General fuzziness indicates crystal growth, and the orientation is becoming less definite. Fig. 30 shows similar spectra after annealing for half an hour at 1200 deg. Cent. The crystals are now large and all traces of orientation have disappeared. The next spectra are of a specimen of "Staybrite" steel which normally has a face-centred cubic lattice. Fig. 31 shows three spectra, N P T. The interesting thing to note about these spectra is that the effect of the rolling is to produce a body-centred lattice with its typical orientation. After annealing for half an hour at 600 deg. Cent., we obtain the three spectra shown in Fig. 32, where the pattern characteristic of a face-centred lattice makes its appearance. These two sets of spectra afford a clear comparison between the two characteristic spectra. In this case the annealing actually destroys the abnormal condition produced by the rolling and restores the normal. As a matter of fact, an expert examination of the spectra in Fig. 31 does reveal traces of the normal face-centred lattice, but there is very little of it.

The next series is interesting as illustrating the effect of straining a metal and obtaining information as to what happens to the crystal units during the process. Fig. 8 is an illustration of the apparatus that was used. The X-ray tube is in the big protective cylinder, and below is a small arrangement in the nature of a tensile testing machine. The test piece, which is very small and thin, is shown at A, placed before a pinhole through which emerge the X-rays, and weights may be placed on the pan at the extreme end of the beam. The film holder or camera is shown at 3. Typical spectra are shown in Fig. 33, A, B, C, D—see Supplement. The actual specimen was steel. A was obtained before any weights were added. B was obtained after the metal had been stretched to just beyond its elastic limit. Here we have evidence of asterism, and the crystals are smaller; they have been to some extent broken up by the process. C is a spectrogram obtained well outside the elastic limit. The crystals are still smaller and the asterism is slightly more marked. D is a spectrogram obtained when the metal fractured. Here it would seem that strain has been relieved with a consequent appearance of definite preferred orientation. It is to be noticed that in these experiments there is no appearance of any change until the elastic limit is reached.

Fig. 9 shows X-ray line spectra obtained by the reflection method. They represent two specimens of electro-deposited nickel obtained by varying the depositing technique. The spectrum marked "dull" will be observed to show several faint lines and one which is very intense. This means that the number of atom planes participating to reflect the rays at this particular angle was very much larger than any other group. As a matter of fact, the intense line is due to the (200) planes, which means that the little crystals of nickel were mainly deposited like little bricks placed regularly side by side. On the spectrum marked "bright," on the other hand, there are at least three intense lines. This indicates that the crystals are not nearly as regularly arranged, but that several groups of planes combine separately to reflect the rays strongly. This means, of course, that the little crystals were deposited with much less symmetry. The specimen of nickel producing the "bright" spectrum was, in fact, much harder than that which gave rise to the "dull" spectrum. This, of course, would be expected. Fig. 11 shows graphs obtained from these two spectra and indicates the relative intensities of the spectrum lines. Fig. 10 shows two more line spectra to show the difference in the spectra produced by α and γ iron—body-centred and face-centred lattices. It is often desirable to examine steels by this method to determine the relative proportion of the α and γ structure present. This may be achieved by a comparison of the intensities of the characteristic lines in the spectrum.

There is another application of X-ray analysis which has not received the experimental attention that it merits. I refer to chemical analysis by means of X-rays. Every element can be made to emit X-rays which have a particular wave length characteristic of the element and of none other. If we wish to analyse a material by X-rays we must make our X-ray tube target of that material. The X-ray tube will then, under suitable conditions of operation, yield characteristic radiation, which, when measured, will be recognised as characteristic of a particular element. It does not matter whether the substance to be analysed exists in a free state or in a state of chemical combination with another. This is one of the important aspects which renders X-ray chemical analysis so valuable in certain cases. The amount of material, too, can be quite small. A recent application of the method in my own laboratory affords an interesting illustration. It was desired to know whether any solder was present in a minute fracture in steel. The fractured steel surface was accordingly mounted as an X-ray target in a special tube and an "emission" spectrum obtained. Certain lines were found on the spectrum characteristic of iron, and also one very faint line in the place where the characteristic line due to lead should appear. The spectrum line is too faint to reproduce in an illustration, but a graph of the spectrum was obtained and is shown in Fig. 12. It supplied undeniable evidence of the presence of lead in the fracture.

From the illustrations and short introduction to the subject that has been given, it is hoped that engineers will appreciate the fact that this new method offers very definite promise in practical engineering problems; but, as I have said before, its development must be aided by the specialised knowledge and practice of those chiefly concerned.

The X-ray diagrams which I have used to illustrate the various applications of the method have been obtained in my laboratory by my colleagues, Messrs. D. E. Thomas, C. G. Pollitt, F. W. Osborne and R. G. Friend.

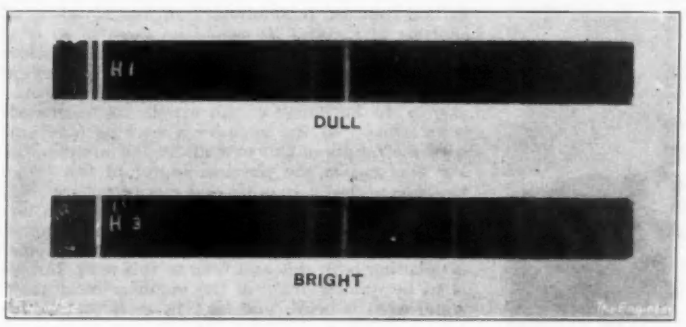


FIG. 9—REFLECTION SPECTRA OF NICKEL

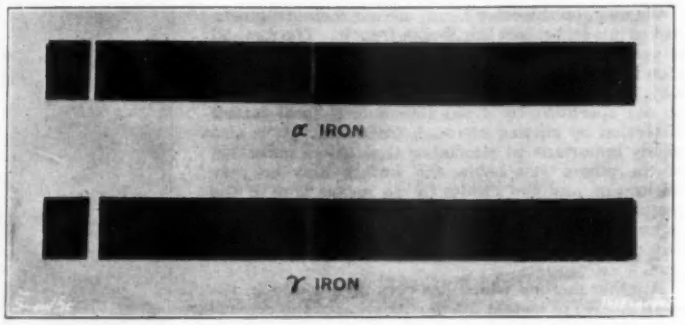


FIG. 10—SPECTRA OF IRON

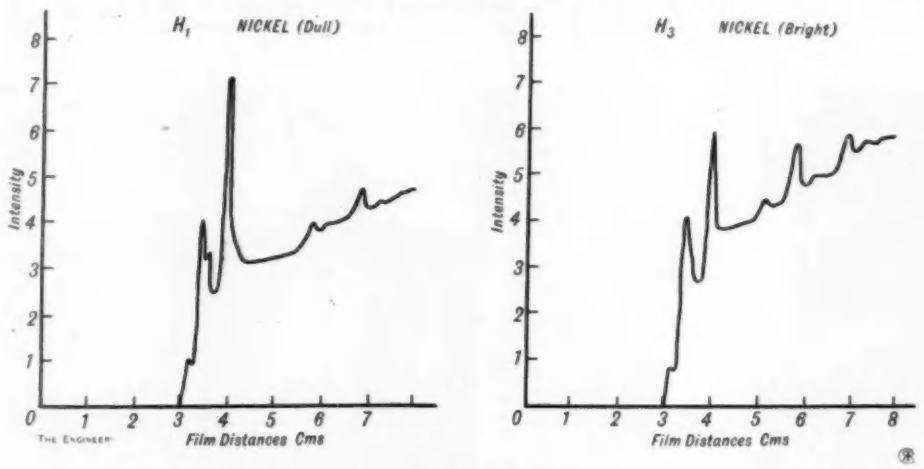


FIG. 11—GRAPHS FROM NICKEL SPECTRA

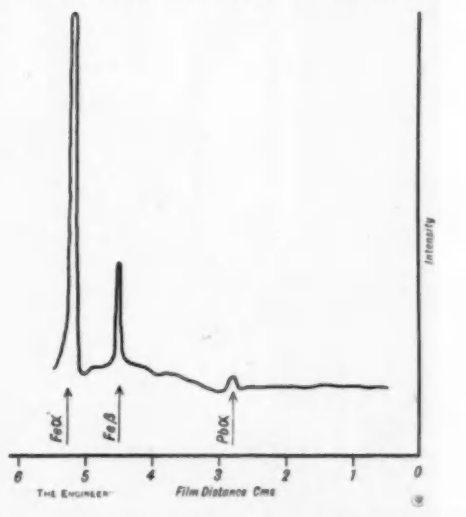


FIG. 12—GRAPH FROM SPECTRUM OF IRON AND LEAD

ITALY and Sardinia are to be linked together by a new wireless telephone service, a transmitter for this purpose being in course of erection at Golfo Aranco. There is no cable communication between the countries.

Institution of Mechanical Engineers.

No. I.

SUMMER MEETING AT BRISTOL.

THE Summer Meeting of the Institution of Mechanical Engineers began at Bristol on Tuesday of this week and ends to-day (Friday). It was attended by about 260 members and about 130 ladies, and marked the third occasion on which the Institution has visited Bristol, previous Summer Meetings having been held there in 1877 and 1908.

On the Tuesday morning the Lord Mayor of Bristol, Councillor Walter Bryant, the Vice-Chancellor of the University, Dr. Thomas Loveday, and the members of the Bristol Reception Committee, welcomed the President, Mr. L. St. L. Pendred, the Council, and the members of the Institution, with their ladies, in the Main Theatre of the Physics Laboratory of Bristol University.

The Lord Mayor expressed the hope that the meeting would constitute a record in the matter of usefulness and enjoyment. Bristol, he said, was a city which was both practical and beautiful and contained many large and many small industries. He congratulated the Institution on its recently granted Royal Charter. He hoped the Institution would come to Bristol more frequently than it had done in the past. Previously it had visited the city in years coinciding with extensions at the docks. On the present occasion it was a little late, for the most recent dock extension had been opened two years ago by the Prince of Wales. Bristol docks, it could fairly be claimed, were twenty years ahead of the times. Each year the trade at the docks had constituted a record. Last year the total trade in shipping entering and leaving the port amounted to 3,429,803 tons. The port dealt last year with 9 per cent. of the country's grain trade and with a very large proportion of the fruit trade, 7,450,000 bunches of bananas alone being imported.

Dr. Loveday seconded the Lord Mayor's welcome on behalf of the University. He referred in particular to the Institution's National Certificate scheme. That scheme, he said, was of particular interest to Bristol University, for it was largely instituted by one of its most distinguished graduates, Dr. Hele-Shaw.

Mr. Pendred replied to the addresses of welcome. He referred especially to Bristol's history as an industrial centre, mentioning the fact that the city was the birthplace of the "Great Western" in 1837, the first steam vessel to cross the Atlantic, and later the "Great Britain," the first iron-built vessel for the same service.

Following the formal opening of the meeting the President presented the Institution's Herbert Akroyd Stuart prize to Professor E. A. Allcut, of Toronto, and a National Certificate Examination prize to a Bristol boy, R. C. Vaughan.

Following the civic welcome, the ladies proceeded by char-à-banc to inspect the city and outskirts of Bristol, while the members listened to and discussed a paper by Mr. A. H. R. Fedden, of the Bristol Aeroplane Company, Ltd., entitled "Air-cooled Aero-engines: A Review of Developments in the Past Ten years." We reprint this paper in full elsewhere in this issue.

In the discussion which ensued on the reading of Mr. Fedden's paper many controversial points were raised by Mr. A. E. L. Chorlton, Dr. A. P. Thurston, Lieut.-Col. Fell, Professor Allcut, and Professor Morgan. On the whole, it may be said that the speakers expressed agreement with Mr. Fedden regarding the advantages of air cooling, but it was noticeable that a feeling that the water-cooled engine had still considerable prospects of development before it was manifest.

After luncheon in the Victoria Rooms, the members separated into groups for the purpose of visiting various works in the neighbourhood of Bristol. Some notes on the works inspected on the first and subsequent days of the meeting are appended. In the evening the members were received at the Museum and Art Gallery and the University, by invitation of the Lord Mayor and Lady Mayoress, the Vice-Chancellor of the University and Mrs. Loveday.

For the Wednesday three alternative whole-day excursions were arranged. One party visited Bath, a second went to Cheddar, visiting the Bristol Waterworks Company's undertakings on the way, and a third proceeded to Yeovil and Sherborne. In the evening the Institution dinner was held at the Grand Hotel, Bristol.

On Thursday whole-day visits were paid to works in the Bristol area, to Dursley and to Melksham, Trowbridge, and Longleat. In the evening a reception and dance was held at the Zoological Gardens, by invitation of the Bristol Reception Committee.

To-day—Friday—the members visited Gloucester, Swindon or Wells, and Glastonbury.

VISITS TO WORKS.

We give below particulars of the history and activities of some of the works and undertakings to which organised visits were paid during the meeting.

THE BRISTOL AEROPLANE COMPANY, FILTON.

This company claims to have been the first in this country organised to make aircraft under production conditions. Established nearly twenty-one years ago, it is to-day probably the largest concern in the world engaged exclusively in the manufacture of aircraft and air-cooled aero-engines. These two branches of production are carried on in separate establishments situated nearly a mile apart, and, with the exception of the administrative offices, each contains its own productive organisation. The aircraft factory occupies an area of nearly 12 acres, and during the war as many as fifty machines a week were manufactured. The aircraft now produced are mainly constructed of rolled or drawn steel strip of high tensile strength by which lightness and strength are combined. The best-known machine produced at the present time is probably the "Bristol Bulldog" single-seater fighter, which has been adopted as standard by the Royal Air Force and several other air forces. The engine department has been in existence for the past ten years, during which time it has been constantly developed to meet the increasing demand for aero-engines. The principal product is the "Bristol Jupiter" radial air-cooled engine, which is also manufactured under licence in sixteen other countries.

THE BRISTOL WATERWORKS COMPANY.

The Bristol Waterworks Company was incorporated in 1846. Before that date the city was supplied by numerous springs and wells. Since then, works have been undertaken from time to time, which give a daily average supply of 16 million gallons to a population of just over 400,000. The extension of the Cheddar works, now in hand, will, when completed, increase the supply to 19 million gallons per day. The consumption during 1929 was at the rate of 13½ million gallons per day.

The principal sources of supply with the dates of the inception of the various works are:—

1846.—Springs at and near Chewton Mendip, at the foot of the Mendip Hills, 14 miles south of Bristol, from which the water gravitates to the storage reservoirs at Barrow Gurney, 6 miles south-west of the city. Springs were also tapped at Barrow Gurney.

1865.—Deep wells sunk in the new red sandstone at Chelvey, 9 miles west of Bristol, from which the water is pumped to the filters at Barrow Gurney.

1846–82.—During this period three storage reservoirs of a total capacity of 870 million gallons were constructed at Barrow Gurney.

1882.—Sherborne Spring, 13 miles south of Bristol, was tapped and conveyed to the city direct. This water is not filtered.

1889.—The Yeo reservoir of 1692 million gallons capacity was constructed at Blagdon, 12 miles south-west of Bristol. The water from this reservoir is pumped into the Barrow storage reservoirs.

1917.—The works at Cheddar, 19 miles south-west of the city, were constructed to provide a supply from the Cheddar Springs, just below their point of issue at the foot of the Cheddar Gorge. This water is at present pumped into Yeo reservoir and thence to Barrow.

The supply which is delivered at Barrow from the several sources gavitates after filtration to Bristol, where it is balanced by covered service reservoirs at Bedminster Down and Clifton of a total capacity of 12 million gallons. This zone of supply meets about two-thirds of the total demand, the remaining third being pumped in Bristol to high-level zones, over 90 per cent. of which is supplied by the Oakfield-road pumping station at Clifton, where plant of a total capacity of 21½ million gallons per day is installed. The balance of the high-level supply is served by five district pumping stations to small isolated high-level zones.

J. S. FRY AND SONS, SOMERDALE.

Messrs. Fry's new factories are situated at Somerdale, about 6 miles from the tramway centre, Bristol, in the midst of some of the most delightful country in the West of England. The area of the site is about 350 acres, and is skirted on three sides by the river Avon. The development of Somerdale factories and the village is remarkable, since there are very few cases on record of a firm which has been in existence for 200 years on one site, transferring the whole of its productive and administrative organisation to new surroundings and new factories. Until a few years ago, about sixteen different factories belonging to the firm were situated within the Bristol city boundary, but since the advent of Somerdale, eight of these factories, with their complete organisation, have been transferred to the new works, leaving eight still remaining at Bristol. The scheme at Somerdale provides for the whole being transferred from Bristol, and the erection of new factories for the accommodation of the remainder is now proceeding. It is expected that within four years' time all manufacturing and administration will be at Somerdale.

The site comprises playing fields and every modern convenience for securing the comfort of the people employed and the quality of the goods produced. The district is full of archæological interest, and during the excavations for the roads and factories many interesting relics of Roman occupation were discovered, all of which have been preserved by the firm in a specially erected museum. The gardens surrounding the factories and the avenues leading to them are a special feature of the Somerdale lay-out.

There are, at the moment, about 2000 people actually employed in the various factories at Somerdale, where the firm's plain chocolate and cocoa products are now produced in their entirety. The confectionery products are still manufactured at the Bristol factories, but will be moved to Somerdale on completion of the extensions now in progress.

W. D. AND H. O. WILLS.

Bristol has always played an important part in the development of the tobacco industry, and it is now the headquarters of the combine known as the Imperial Tobacco Company (of Great Britain and Ireland) of which the firm of Messrs. W. D. and H. O. Wills is one of the four branches in Bristol, and the most important branch of the company. The first mention of the name of Wills in connection with the tobacco trade in Bristol is in a notice in a local paper of 1789, which stated that the firm of Wills, Watkins and Company was dissolved so far as Samuel Watkins was concerned, and would be known in future as Wills and Co. The Wills referred to was Mr. H. O. Wills, who came to Bristol from Salisbury and founded the firm sometime between 1786 and 1788. The name of the firm was constantly changed during the following century as new partners joined and left it or as it incorporated other concerns. Its most important amalgamation was with the firm of Ricketts in 1833, a firm the predecessors of which dated back to 1730. The formation of the Imperial Tobacco Company took place in 1901.

The factories of Messrs. W. D. and H. O. Wills are models of modern hygiene and the comfort of the employees is studied in every possible way. Each factory has its dining rooms, dental treatment is provided free, rest rooms and nursing services are available, all kinds of welfare work have been adopted and the company has provided one of the finest athletic grounds in the country.

The tobacco leaf is brought into the factory in hogsheads, where it is unpacked, weighed, and sorted for quality. It is then put through a steaming machine for softening, and after the stems have been removed is sent to the cutting room. It is then opened out on wooden trays to cool, and stored away. From the store room quantities of tobacco are sent on trolleys to the packing room as required, and there the tobacco is weighed and packed ready for dispatch to the retailers.

The production of roll tobacco is dealt with in a spinning department, where suitable tobacco leaves are spun into twist. The tobacco is later made into rolls of different weights, which are placed in hydraulic cool presses, and after a few days are transferred to hot-plate presses. After this process they are again placed under pressure until required for dispatch.

From a spectacular point of view, cigarette making is the most interesting department. Here there is a whole battery of machines which receive tobacco at one end and deliver completed cigarettes at the rate of hundreds a minute at the other. As they fall out of the machines the cigarettes are taken to the packing machines. The cigarettes are automatically counted and placed in their packets, and a picture card is inserted—all by machinery.

Cigar making may also be seen. It is a skilled handicraft, the inner or "filler" portion of the cigar being wrapped in a specially selected and cut leaf by hand. The completed cigars are sorted for colour and stored to mature, often for several years.

THE PORT OF BRISTOL AUTHORITY.

The Port of Bristol, which includes the City Docks and the larger rivermouth docks at Avonmouth and Portishead, has a history extending back over 2000 years to the days of the Phœnician traders. The first engineering works were undertaken between 1239 and 1247 when the St. Augustine Trench was constructed by the diversion of the river Frome, which made a deep-water channel for ships and a quay at which they could lie. For centuries, vessels were discharged and loaded at landing places along the banks of the tidal river Avon, which flowed through the heart of the city. In 1809 a new course for the river was formed, and the old waterway for a length of 2½ miles was converted into a floating harbour, now known as the City Docks.

In 1877 the Avonmouth Dock—the first rivermouth dock—was constructed, and in 1879 the Portishead Dock on the opposite bank of the mouth of the river was opened. Both these docks were acquired by the City Corporation in 1884, and since that date the whole of the docks system of the port has been owned and controlled by the Corporation of Bristol.

The Royal Edward Dock, Avonmouth, the most modern dock in the port, was constructed by John Aird and Co., and opened by King Edward VII. in 1908. It is connected with the Avonmouth Dock by a junction cut 85ft. wide. Both docks are equipped with extensive shed and warehouse accommodation for import and export traffic, and there are five large granaries capable of storing 360,000 quarters of grain; floating and shore grain elevators; a cold store connected with the quayside by escalator galleries; transit sheds, warehouses, timber sheds, and storage ground; electric elevators for discharging bananas; electric, hydraulic, and steam cranes, and a large floating crane, &c. A number of the large oil corporations have tank storage installations on the dock estate directly connected by pumping lines with the oil-discharging berths. The installations cover an area of 80 acres and contain tanks of a capacity exceed-

ing 80 million gallons. A graving dock of the same dimensions as the lock is entered from the Royal Edward Dock.

In 1928 H.R.H. the Prince of Wales opened the Eastern Arm extension of the Royal Edward Dock, constructed at a cost of nearly 1½ millions sterling. This arm, approximately 1800ft. long and 400ft. wide, provides three deep-water berths on each side, having a total length of quay of 3600ft. and a water area of 21 acres. The wharves on each side of this extension are constructed wholly of reinforced concrete supported on reinforced concrete piles.

The City Docks are situated 7 miles up the river Avon in the heart of the city and are mainly used for continental and coastwise traffic. Alongside the docks are public quays, transit and other sheds, a granary, tobacco warehouses, and many private wharves, factories and timber yards.

Portishead Dock is equipped with a granary and sheds for grain storage, and a special wharf, sheds, and stacking ground for timber.

The docks are administered by a Committee of the Corporation under the style of the Port of Bristol Authority, of which Alderman Edward M. Dyer, J.P., is the chairman, and Mr. Thomas A. Pearce is the general manager and chief engineer.

Stothert and Pitt, Bath.

This company commenced operations in the early part of last century, and in the year 1883 was converted into a limited liability company. The works have from time to time been extended and now consist of the principal or Newark Works, and the branch or Victoria Works, both situated on the Lower Bristol-road. Both works are on the riverside, and the Victoria works are connected by a siding with the London, Midland and Scottish Railway. The Newark Works contain the main offices, machine shops, erecting shops, stores, foundries, pattern shop, smiths' shop, tool room, electrical fittings department, power-house, and a yard for the erection of finished work. During the war, a large shop was built at the west of the yard for munition work. This shop is now used as a fitting shop for cranes, conveyors and patented rotary pumps, the last two having now become a very important part of the firm's productions.

The Victoria Works comprise a large structural shop, stockyard, fitting shops, stores, power-house, erecting shops and yards for erecting finished work. The design and manufacture of concrete mixers and modern road-making machinery is an important branch of the firm's productions which is carried on at these Works.

The first heavy machine shop has a floor area of 150ft. by 48ft., with upper galleries for small tools and electrical fitting work. The second heavy machine shop is 160ft. by 52ft. with an upper floor at the east end for light machines. A third machine shop at the east end of the works adjoining the smiths' shop is approximately 165ft. by 49ft. In the first machine shop some very large tools are employed; whilst the upper floor of the second machine shop contains several special tools, including those for cutting the rotors of the firm's rotary pumps, and a special tool for turning, boring and facing conveyor idlers.

The structural shop at the Victoria Works has a floor area of approximately 270ft. by 110ft. in two spans, and is surrounded by a stockyard. The fitting shop is 24ft. by 50ft. wide and a 60ft. extension on the river end is now in progress. An erecting yard, served by a 21-ton steam crane mounted on a travelling gantry, 40ft. high, and several small runabout cranes, lies between the two shops.

Considerable alterations and extensions to the works are now being carried out. The foundry is being moved from the Newark to the Victoria Works, and the old foundry building is being converted into a fitting shop. A new high erecting shop is in course of construction, about 80ft. to the ridge of the roof, and 170ft. long by 65ft. wide. The building is to be fitted with sliding doors, 50ft. high along one side, so as to enable dockside cranes to be completely erected under cover and pushed out into the yard for test. This will add a shop area of 21,000 square feet to the Newark Works.

The Westinghouse Brake and Saxby Signal Company, Chippenham.

The factory stands on an area of 10 acres adjoining the Great Western Railway. The original shops were built by Messrs. Evans, O'Donnell and Co., in 1895. In 1903 Messrs. Saxby and Farmer acquired the factory and removed their works from Kilburn, London, to Chippenham. In 1920 this firm amalgamated with the Westinghouse Brake Company, of London, and Messrs. McKenzie and Holland, of Worcester, the latter removing their works from Worcester to Chippenham. Advantage was taken of this amalgamation to reorganise, extend, and re-equip the buildings, which are therefore up to date as regards plant and equipment.

The following are the chief departments:—Foundries, iron and non-ferrous, with pattern shop, and stores, &c., 52,000 square feet; smithy and drop forging, 18,000 square feet; machine shop, 39,000 square feet; fitting shop, 21,000 square feet; instrument shop, 15,000 square feet; rectifier shop, 15,000 square feet; woodworking shop, 14,000 square feet; iron signal shop, 13,500 square feet. In addition, there are smaller departments, such as the bakelite moulding and electro-plating departments, sheet metal and tinsmiths' shops, test rooms, packing sheds, stores, &c.

The products consist of a large variety of articles used in railway signalling, both manual and power operated, together with electrical instruments, air compressors and air brakes, vacuum brakes, automobile vacuum servo brakes, metal rectifiers in many sizes, interlocking frames, single-line token instruments, colliery decking plant, &c. Approximately 1300 people are employed.

R. A. Lister and Co., Dursley.

This firm was founded in 1867 on the site occupied by the present Lister cream separator factory, and is engaged in the manufacture of appliances for agricultural and industrial purposes. The most important products of the firm are petrol-driven trucks of 1-ton capacity embodying a patented turntable which enables the vehicle to be completely reversed by swinging the steering unit through half a circle; tractors of hauling capacity up to 24 tons, built specially for operation on narrow-gauge rails; petrol engines of 1½ to 20 H.P.; cold-starting, solid-injection Diesel engines, including the smallest type of vertical Diesel engine in the world, of 5 B.H.P.; electric light plants of 500 watts to 27-kW capacity; and hand, power and electric cream separators. A recreation and social club is run in connection with the firm, of which the employee-members are shareholders. The club has excellent headquarters with a hall having a seating accommodation of 900, and playing fields covering nearly 20 acres. About 2000 people are employed at Dursley and elsewhere by the firm.

The Gloucester Railway Carriage and Wagon Company, Gloucester.

The company was formed in 1860 for the purpose of building railway coal wagons, and originally occupied only 5 acres of land rented from the Gloucester Corporation. On this ground shops were erected which covered about an acre, and they sufficed for the business of the company until 1877 when the first addition was made. The present works cover 32 acres and are devoted to the manufacture of railway stock for home and abroad. Dining and sleeping saloons built of steel or timber are manufactured, as well as steel and wood wagons, pressed steel bogies and underframes, pressed steel goods wagons of high capacity, wheels and axles and heavy forgings of every description. The company controls a modern foundry for the production of malleable iron and grey iron castings, wrought iron pulleys, and conveyor drums. The works are situated on the Gloucester and Berkeley Ship Canal, and have direct access to the sea.

The carriage shops cover a large area, and are capable of constructing carriages 80ft. long. A special section is allotted to pressed steel work. This department is fitted with hydraulic plant suitable for the manufacture of pressed steel underframes up to 50ft. in length, pressed steel bogies, doors, sides of wagons, and parts for steel coaches. The company also has extensive saw mills, and converts a large quantity of the timber used direct from the log.

The erecting shop is 69,200 square feet in area, and is served by four electric overhead travelling cranes, two of 10 tons, one of 8 tons, and one of 5 tons capacity. It also contains eleven swinging, counterbalanced, beam cranes carrying hydraulic riveters of various sizes up to 8ft. gap, machines for roofs, &c., the work being moved into the radius of such cranes on special roller bearing trestles. The machine shop covers an area of 48,100 square feet and is served in the portion where the heavier articles are machined by a 3-ton overhead electric travelling crane.

The coach body paint shop is approximately 13,800 square feet in area, and is steam heated to keep an even temperature during cold weather. The body shop covers an area of 37,800 square feet, and contains twelve roads, each 160ft. long, for the accommodation of coaches under construction.

The woodworking mill is 38,250 square feet in area, and contains sixty-eight machines of the usual types. Each machine is connected to a dust-collecting plant, which deposits the dust and chippings in the boiler-house some 400 yards away. The log-converting mill has an area of 10,800 square feet, and is served by an electric overhead travelling crane of 5 tons capacity. It contains two large "Ransome" band saw mills, one horizontal and one vertical, together with eight rack, cross-cut, and circular saws. These machines are connected to an overhead system of dust-exhaust piping.

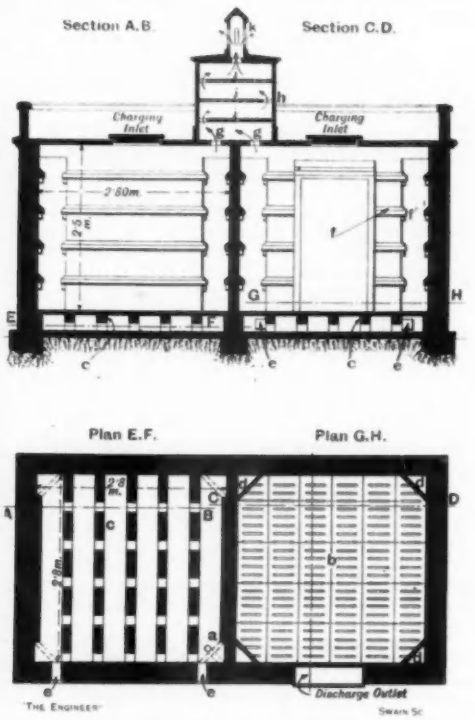
(To be continued.)

THE site of the public demonstrations in connection with the World Agricultural Tractor Trials, which are being held in England this summer under the auspices of the Royal Agricultural Society, has been transferred from Wallingford to Ardington, near Wantage, with a view to providing the most thorough ploughing tests on stronger and deeper soil. The demonstrations, at which over thirty tractors from England, America, France, Germany and other countries will be seen at work, will be held from September 16th to 19th inclusive.

Refuse Disposal in France and the Beccari Process.

(Contributed.)

THE incineration of town refuse in France has, in some cases, given satisfactory results, and in others it has failed, and, now that the problem of refuse disposal has assumed so much importance, there is some criticism of incineration methods and an inquiry into other processes that may possibly replace them. Prominence has been given to this matter of late by the refusal of the municipalities in the Department of the Seine to incur the cost of putting down incineration plants in accordance with the recommendations of the Prefect of the Seine. The programme of extension, which will result in Greater Paris covering practically the whole of the department, provides for a unifying of all the suburban municipal services. The incineration of refuse is the only process employed in Paris, and the Prefect has requested the suburban authorities to adopt the same method. That request has aroused considerable opposition on the ground that the Paris incineration works are unable to burn all the refuse, much of which has to be crushed and cannot always be sent away as manure on account of the cost of transport, while the works are also declared to be detrimental to public health. Some of the suburban municipalities, therefore, state that, if incineration is to be adopted, the plants should be removed beyond the residential quarters. Other objections to incineration come from the South of France, where the system has failed, partly on account



SECTIONS AND PLANS OF BECCARI CELLS

of the high proportion of vegetable matter in the refuse that can only be burnt with great difficulty. Marseilles has decided not to burn its refuse. At Toulon, Antibes and Nice the incineration plants have ceased working, because the cost is found to be too great. The plant at Monaco is operating with coal, but that, in the case of less wealthy towns, is out of the question. On the other hand, the municipality of Lyons has arranged to instal a German type of incineration plant.

The choice of a system of refuse disposal depends upon the nature of the refuse and upon local conditions, and while in some cases the vegetable matter is readily burnt with the rest, and steam can be raised for generating electrical energy and for other purposes, such conditions do not prevail in the South of France, where the vegetable refuse is difficult to burn and its value as manure in agricultural districts is considerable. This question of providing a natural manure in place of the expensive chemical fertilisers, which might impoverish the soil if used for too long periods without interruption, has drawn attention to systems of refuse treatment based upon a bacterial transformation of the vegetable and animal matter. The method at present employed is that introduced into Italy by Dr. Beccari, and after being in operation at Florence, Carrara and other towns, it was selected by the municipality of Cannes, where an installation has been working for about two years, with, it is declared, entirely satisfactory results. Similar plants are now to be laid down at Avignon and Aix-en-Provence. Most towns merely crush the refuse and send it away as manure, and while that method is unsatisfactory from a hygienic point of view, the material may lose its fertilising value before it can be used. In the Beccari process the vegetable

and animal products are placed in closed tanks or cells, as they are called, where they are fermented, the temperature reached being, it is stated, high enough to eliminate all nitrate-destroying bacteria. The product is in the form of a sterilised dark loam that can be stored in sacks and sold to farmers in the spring and autumn when there is a demand for the manure.

Plans and elevations of two cells on the Beccari system are shown in the accompanying engraving. The cells are built of concrete and each has a capacity of about 20 cubic metres. The concrete floor is inclined for drainage of the liquid into a sump *a*, whence it is removed from time to time and returned to the top of the cell to facilitate the fermentation. Above this is another floor *b* perforated for the passage of the liquid and carried on traverses *c*, the lower parts having semi-circular openings to allow of the liquid passing freely. At the corners of the cell are air shafts *d* with air vents *e* communicating with the outside. The shafts have apertures f^1 underneath the fillets *f* to ensure that the air is distributed all round the mass. The air has an important effect upon the fermentation. In a short time the temperature of the mass rises to 60 deg. Cent. and more, and then there is a formation of ammoniacal products and an elimination of the nitrate-destroying bacteria. The heat spreads gradually from the interior to the walls of the cell and then, when the temperature falls to 45 deg. or 50 deg. Cent., the air penetrates into the mass and completes the fermentation. Meanwhile the rising gases encounter a current of cold air underneath the cover of the cell and most of the volatile products condense and fall on the fermenting matter. The gases escape through the apertures *g* into the chimney *h*, which is provided with perforated baffle plates *j*, on which are placed some absorbent materials such as iron sulphates, accidulated lime or plaster. These materials convert the ammoniacal vapour into ammonia sulphates and nitrates, which return to the cell, and the gases escaping by the apertures Z are, it is said, perfectly free from smell. The complete operation occupies about 35 days. The cells, therefore, can only be charged nine or ten times a year, and that would appear to necessitate considerable space in order to deal with the refuse of large towns, but there would be no difficulty in building the cells one above the other.

Apart from the conversion of all fermentable matter into a particularly valuable manure, which is the basis of the Beccari process, there is a commercial utilisation of all other products, for which purpose the installation at Cannes is provided with magnetic separators and endless conveyors for the separation of other than metallic objects and everything is done mechanically, except the actual sorting of the materials. The volume of refuse dealt with daily at Cannes is about 115 cubic metres. The installation has been put down by a company which has contracted to deal with the whole of the town refuse. The concession under which it operates has a duration of 25 years, and the town is to pay to the company 365,000 francs a year towards the cost of maintaining the plant. At the expiration of the 25 years the installation will become the property of the municipality. The company collects the refuse and pays to the municipality 96,000 francs a year, so that the net amount received by the company from the town is 239,000 francs per annum.

The cost of a Beccari installation is declared to be about the same as that of an incineration plant, but the cost of upkeep is much less, and in view of the agricultural value of its product, independently of any question of economy, the process obviously presents interest.

Rail Rates on Iron and Steel.

By E. T. GOOD.

RECENT statements about the rail rates handicap on iron and steel, made by representative traders and manufacturers, have been so widely reported, quoted, and noted, but are in some particulars so inaccurate, that a few corrections may be respectfully offered. Transport costs is so important that the truth about the matter ought to be known and faced fairly and squarely.

We are invited to believe that our industries suffer from the highest transport charges in the world, simply because our rail rates per ton-mile are the highest; but ton-mile rates have nothing to do with competition. The real fact, or factor, is the total charge from point to point—the inclusive transport cost from mines to works and from mines to port or point of consumption. A rate of 3d. per ton-mile for a 20-mile haul is not such a handicap or charge as a penny rate for a 100-mile haul. This is the country of short hauls; therefore, our rates are high. But our total charges are low. The rail rate handicap is on foreign, not on British steel.

The best account of rail charges or inland transport costs on steel yet published is that supplied by the *Iron Age* expert, Mr. Paul M. Tyler, about two or three years ago, after a thorough investigation. Here are some of the figures in handy form:—

Transport costs on steel, in dollars per metric ton; that is to say, the inclusive costs of assembling the materials at works and carrying the finished products to port of shipment, per ton of product:—

	Dollars.
In Britain when imported ore is used	5·20
In Britain when home ore is used	5·05
Belgium	6·30
Luxemburg	7·05
Lorraine	7·30
United States	14·20

Mr Tyler found a firm in the Sheffield area which gave its assemblage costs per ton of pig iron as 2·50 dollars, whereas the costs in Pittsburg area average 7·30 dollars. He shows that the post-war rail rates increases in the United States vary from 60 to 75 per cent., and "in some cases more." That means a vastly bigger increase in the total charges than our 50 to 60 per cent. increase, because the length of haul in America is hundreds of miles against our tens of miles. Mr. Tyler shows that the post-war increases in Germany are 60 per cent. on pig iron and semi-steel, between 25 and 125 per cent. on finished steel, and on railway steel 193 per cent. for 25 kiloms. (15½ miles), and he concludes, with perfect truth, that British rates have "increased less than those elsewhere." This statement is amply confirmed by a special report in our *Board of Trade Journal* a few years ago, and subsequent information. It was shown that shortly after the war, as compared with pre-war, all rates in Belgium had been increased by 100 per çent.; goods rates in France by 140 per cent.; in Norway and Sweden by 200 per cent.; in flat Holland by 75 per cent.; and in Portugal by 140 per cent. Since then our rates have been reduced from the 100 per cent. advance made by the Government to between 50 and 60 per cent. since reversion to company management, whilst abroad there have been more increases than decreases since the Board of Trade report was issued. A carefully compiled set of figures published in *Modern Transport* as recently as May 3rd, 1930, shows that the post-war rail advances reckoned in actual receipts per ton-mile have been the least in the United Kingdom. Returns are given for eighteen countries, and all the foregn countries have suffered bigger increases in rail rates than we have. The percentage increases, given in index figures, for the leading steel producing countries, are as follows:—

	Per cent. increase.
United Kingdom	22·4
Germany	37·9
Belgium	41·5
United States	48·9
France	203·8

These figures are not strictly applicable to steel. They cover all goods, and there have been post-war changes in proportions of various goods and in lengths of hauls; but the broad fact remains that our ton-mile increases have been the lowest, and that, with our increases being on short hauls, whereas foreign increases are for long hauls, the actual extra charges or post-war increase have been far greater in foreign steel countries than in Britain. We held a transport cost advantage before the war. We hold a much bigger advantage to-day. Bulking all goods together, average hauls are 54 miles in Britain, 59 miles in Belgium, 89 miles in France, 95 miles in Germany, and 300 miles in America. Taking only the heavy trades or traffic—that is to say, ore, fuel, iron and steel—average hauls are in round figures 30 miles in Britain, 70 miles in Belgium, 150 miles in Germany, 200 miles in France, and 500 miles in the United States. Rates per ton-mile have to cover terminal work, and as there is as much terminal work on short-haul as long-haul traffic, it follows that the country with the shortest hauls must have the highest rates; but the total charges, and not the rates per mile, constitute the competitive factor; and it is in this respect—on the only point that matters—that the British trader enjoys the cheapest inland transport in the competitive world.

In spite of the above big differences in length of haul or number of railway miles for which goods are charged, the actual receipts per ton-mile for all goods averaged are as follows, according to the figures given in *Modern Transport*:—

	d.
United Kingdom	1·42
Germany	0·945
Belgium	0·80
France	1·897
United States	0·543

Obviously, the lowest foreign rate per ton-mile is a far bigger point-to-point charge than the British rate. For mineral traffic—coal, iron, steel, &c.—the average pre-war rail rates per ton-mile measured by railway receipts, were as follows:—In Britain, 0·9d.; in Germany and France, 0·6d.; and in United States, 0·4d.; but, as mentioned, we had much the shortest and therefore the cheapest hauls then. Now our advantage is much more pronounced.

The late Mr. J. Stephen Jeans, when secretary of the British Iron Trade Association and editor of the *Iron and Coal Trades' Review*, when writing his book on "The Iron Trade," from a British industry standpoint, before the war, was obliged to quote figures which demonstrated that inclusive transport charges on fuel, iron and steel were lower in our country than in America and continental Europe. In order to make out any sort of case for our industry for lower rail rates, Mr. Jeans was constrained to take the extreme case of Staffordshire works, as far from port as British works could be, give their transport costs as if all their products had to go to a port, and compare the total with the lowest charges abroad. He had to rely mainly on ton-mile rates for a case, but he was honest enough to write as follows: "It would be uncandid to ignore the fact that British conditions do not lend themselves to low ton-mile rates to the same extent as those of continental countries and the United States; first, because of the shorter hauls and relatively high terminal charges; next, because of the much higher cost of railway construction in this country; and, finally, because of the difference in the conditions and methods of handling traffic." That is so to-day—only much more so. Our railways cost most to make and maintain because of the hilly nature of our country; most to operate because of our short hauls, high wages, and other factors; and not least because of the small consignments sent by or ordered by our traders, as compared with the "bulk" train loads offered by foreign firms.

The Parkgate Iron and Steel Company with its plant near Sheffield, almost as far from a port as a British plant can be, cannot figure out its inclusive inland transport charges at more than 28s. 9½d. per ton of finished steel up to the ship's side; that is to say, all the assemblage costs for ore, fuel, iron, &c., to make the steel, the fuel to convert and roll the steel, and the cost of carrying the steel to a port. Against this extreme British cost, the average cost is 59s. 6d. per metric ton in the United States, and a metric ton is not so much as an English ton. Even in tiny Belgium, with its flat land and cheap railway construction, a ton of steel carries more transport cost than a ton of British steel; in Germany and France steel carries much more, and in America far more, in transport charges than our steel carries. To sum up, British traders have a substantial transport cost advantage over all their competitors.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

'PRENTICES AND COLLEGE WORKSHOPS.

SIR,—I have read with much interest the editoria note in your number of June 20th on the subject of apprentices and college workshops and have also carefully read Professor Birstall's article.

I am wholeheartedly a supporter of your views, *i.e.*, that practical experience in works is absolutely essential in the education of an engineer. The vital need for this, however, is, in my opinion, one which you do not mention. So long as works employ men and so long as man remains as he is, the most intricate machine created, so long will it be of supreme importance that engineers learn the control of this intricate piece of mechanism.

It is absolutely true that the greatest leaders of men are born and not made, but the average man can acquire a very great deal of the necessary powers of leadership by working alongside those whom, in due course, he will control. He cannot, however, learn it at a university, and, in my humble opinion, a very large amount of the labour troubles, which have been the curse of the country, would have been avoided had a fraction of the attention been given that the subject merited. As a matter of fact, it has been largely taken for granted.

Another mistake which I think is made in the training of engineers lies in keeping them at public schools until they are 18 or 19, and it is partly for this reason that university professors are so insistent on the cutting out of pupilage in works.

It is worth bearing in mind that it is a great deal easier to do boy's work when you are of boy's age, and unless you are an enthusiast and your personal dignity counts for little, as it certainly should, it is a hard job at 20 or 21 years of age to go into works and cut a poor figure, so far as skill goes, compared with lads of 16 or 17, and in my humble opinion it is this point that is at the back of the cry that workshop experience is not necessary, whereas, of course, it is of supreme importance.

In my opinion, a boy who is going to be a mechanical engineer should leave school between the age of 16 and 17 and go straight into a works, serving three years there. I am not a believer in his going to evening classes, because I feel that if he does an honest day's work he should be so physically tired by the end of that day that he will not be in a fit state to attend to lectures, but in all human probability will go to sleep.

At the end of the three years' apprenticeship, if this apprenticeship has been served in a works where the management is reasonably intelligent and sympathetic, he will have formed a very good idea of what branch of engineering he is going to follow, whether it be designing, salesmanship, or works management, and can then, with advantage, go to a university for a longer or shorter period, according to whether he is going to take a degree course or not.

His practical experience will enable him to see the vital bearing the theoretical has on the practical, whereas, if he came straight away from a public school he is liable to look upon lectures as dry bones and concentrate on having a good time.

During his period of college training he could reasonably include all the drawing-office work that he was likely to require if works management or salesmanship was to be his bent. If designing, he could on leaving college take a post as draughtsman with a good ground work in correct drawing-office procedure.

Stoke-on-Trent, July 1st. R. W. WILLANS.

LAND MARLING MACHINES.

SIR,—With reference to your interesting article in the current issue of THE ENGINEER on land marling machines, it occurs to one that this machine may do its work extremely well, but as the practice of marling is very limited in this country, this machine would be of greater advantage, if modified, to agriculture, for digging the trenches for pipe drains.

There is no county in Scotland, England or Ireland which is not crying out for an efficient machine to cut the pipe trenches, and this machine could be adapted to leave the soil in two banks, and after the pipes have been laid, to turn over the same ground, filling the soil in the trenches again.

If the manufacturers of this machine can convert it satisfactorily, there is undoubtedly a bigger demand than for anything which has been produced to assist agriculture for many years.

Slough, July 1st. GREGOR MACGREGOR.

A REPORT from New Zealand states that a new device which, it is claimed, will prevent aeroplanes from stalling, has been perfected by Mr. C. Hughes, a young resident of Auckland. Besides eliminating stalling, the invention, it is said, will enable aeroplanes to take off and land in about half the distance now required. No particulars of the invention are yet to hand.

The Royal Agricultural Show at Manchester.

No. I.

ALTHOUGH only sixteen years have elapsed since the Royal Agricultural Society of England held its annual show in Manchester, the Society acted wisely when it accepted the invitation of the citizens of that city to hold its 1930 exhibition there. All the previous Shows held in Manchester have been financial successes. Lancashire people, and especially those who work in the manufacturing districts, are greatly attracted by the many phases of country life which are presented by these agricultural displays. Nor is their interest confined exclusively to live stock, dairy equipment and poultry. Engineering in one branch or another enters into the lives of a large section of the people of Lancashire, and the machinery in motion in the implement section of the Royal Show cannot fail to be of interest to those who have no special fancy for the other branches. On the last occasion that the Show was held in Manchester the Empire was engaged in war and the conditions were all against success; still, notwithstanding the difficult circumstances, the results were remarkably good, the exhibits of live stock being only slightly below the average, though, as was to be expected, the implement sections suffered badly for the obvious reason that practically all the agricultural engineering firms were engaged in the production of war materials. The length of shedding in the implement yard amounted to 7070ft. and the number of stands was 239. For the Show which is being held this month—from the 8th to the 12th inst.—the entries in all sections of the showyard are again rather below the average, except in the machinery section, in which there will be 443 stands. This is rather better than at Harrogate last year, but not as good as at Nottingham in 1928.

The following are the principal entries this year:—Horses, 512; cattle, 1164; sheep, 735; pigs, 678; poultry, 901; produce, 506. In the implement section the total length of shedding is 10,693ft., which is somewhat less than last year.

The showyard will be found to be very compact. The area is just under 90 acres and there is no waste space. It is situated within about 3 miles of the centre of the city and can be reached readily either by road or by rail. As far as we have been able to ascertain, the number of really new implements is below the average, and that statement is borne out by the list of entries for the Society's silver medals, of which there are only six. That is quite the smallest number that we can recall, and it is probably due to a stricter enforcement of the governing conditions.

The entrants for the silver medals are as follows:—Harrison, McGregor and Co., Leigh, Lancs., expanding horse rake; Clayton and Shuttleworth, Ltd., Lincoln, harvester-thrasher; Bamfords Ltd., Uttoxeter, expanding horse rake; International Harvester Company of Great Britain, Ltd., London, grinding mill; the Alfa Laval Company, Ltd., magnetic milker; and Walter A. Wood and Co., super cultivator. The agricultural tractor in various forms will be adequately represented and practically all the leading makers of oil, petrol and gas engines will exhibit their standardised productions. Motor coaches will form a very prominent feature of the showyard, although their particular connection with agriculture is not immediately obvious.

In connection with the agricultural tractor section great interest will be taken in the series of trials which is being organised by the Royal Agricultural Society in conjunction with the Institute of Agricultural Engineering at the University of Oxford. These trials will consist of two parts, the first being tests of a scientific and practical nature, not open to the public, and the second comprising a demonstration open to the public, which is to be given at Ardington, near Wantage in Berkshire, from September 16th to 19th next. Nearly thirty machines have been entered for these trials, the results of which will be awaited with much interest. The names of the firms which have entered machines for these trials are as follows:—Peter Brotherhood, Ltd., Peterborough; Blackstone and Co., Ltd., Stamford; Aveling and Porter, Ltd.; Rushton Tractor Company, Ltd., Walthamstow; Vickers (Crayford), Ltd.; Marshall, Sons and Co., Ltd., Gainsborough; Ford Motor Company; the International Harvester Company of Great Britain, Ltd., London; Massey-Harris, Ltd., London; Associated Manufacturers' Company, Ltd., London; Latil Industrial Vehicles, Ltd., London; Citroën-Kegresse Ltd., Hammersmith; the Caterpillar Tractor Company, San Leandro, California; Heinrich Lanz A.G., Mannheim, Germany; Linke-Hofmann Busch-Werke A.G., Breslau; Société Anonyme Austin, Paris; Munktells Mekaniska Verkstads Aktiebolag, Sweden, and George Monro, Ltd., Waltham Cross. This ought to prove one of the most instructive tests of industrial tractors which have ever been carried out, especially as many of the machines entered will be propelled by engines using crude or Diesel oil for fuel.

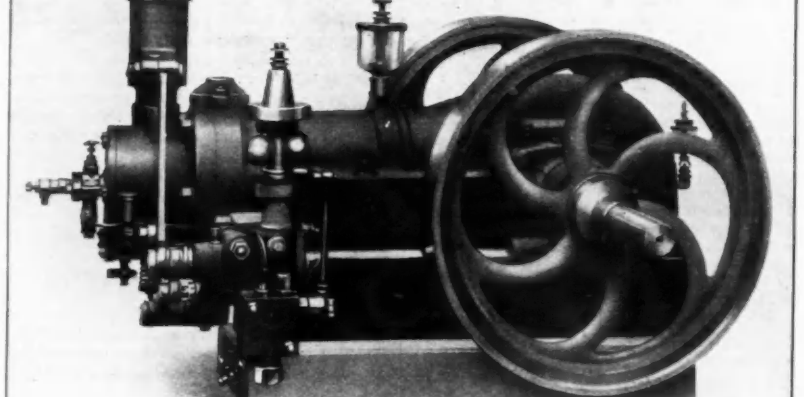


FIG. 1—6½ H.P. FUEL-OIL ENGINE—NATIONAL

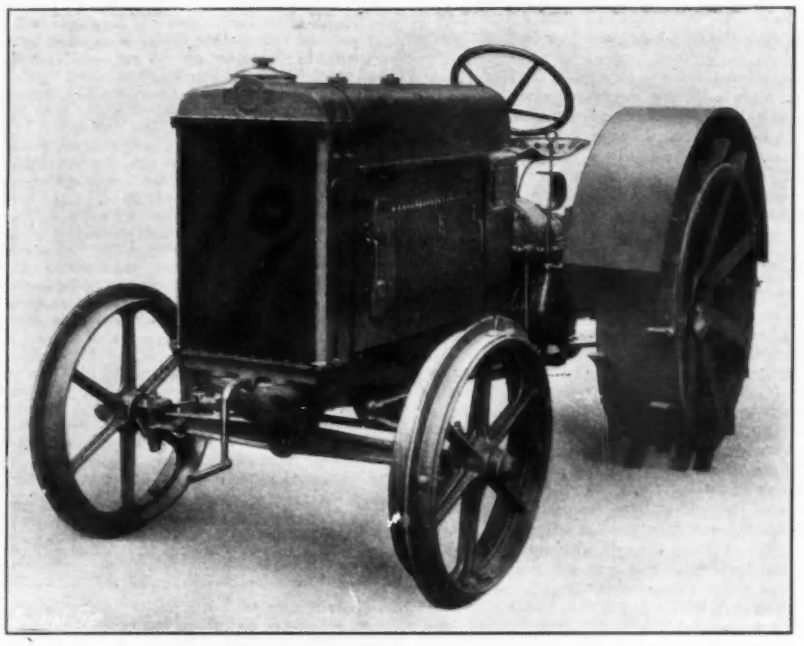


FIG. 2—22 H.P. PARAFFIN TRACTOR—RUSHTON

The future of the industrial tractor is closely bound up with the development and application of the crude oil engine, either of the Diesel or so-called semi-Diesel types. J. and H. McLaren, Ltd., Leeds, have for some years been engaged in the building of high-speed heavy oil engines suitable for tractor driving as well as for the operation of stationary machinery and electric generators. These machines are built in sizes from 6 B.H.P. up to 90 B.H.P. under Benz patents and several engines of this type will be on view at the Show.

NATIONAL GAS ENGINE COMPANY.

There will be nothing strikingly new on this firm's stand, and with the exception of the 6½ B.H.P. horizontal single-cylinder oil engine illustrated in Fig. 1, all the other engines have been described in these pages. The 6½ horse-power engine is one of simple design and robust construction to withstand the hard wear and rough usage to which such power units are frequently subjected on farms and estates. It is intended to operate on the lighter grades of fuel oil and is of the four-stroke type running at about 600 revolutions per minute. It will be noted that the crank shaft is totally enclosed, but the cover can be easily removed to permit of inspection and for withdrawing the piston and connecting-rod. Other engines shown by this company will be a heavy-oil engine which generates 110 maximum brake horse-power

FIG. 3—HEAVY-OIL ENGINED LORRY—KERR, STUART

at 250 revolutions per minute, and which starts from cold by means of compressed air. In this engine neither compressed air nor springs are used for the injection of the fuel oil, which is delivered by direct mechanical means through a special form of atomiser into the combustion chamber. The exhibit will also include a 7-kilowatt lighting set in which a heavy-oil engine which drives a dynamo through a texrope and provides a small power unit of economical form which uses the cheapest oils. Two small engines, developing 2¼ to 2¾ horse-power, operating on paraffin, but starting on petrol, either with hopper cooling or thermo-syphon, and driving a dynamo and air compressor respectively, will also be shown in operation, together with a non-chokeable pump driven by a 6 horse-power vertical paraffin engine.

RUSHTON TRACTORS.

The well-known Rushton tractor—illustrated in Fig. 2—uses paraffin as fuel. It will be shown in various forms, *i.e.*, for agricultural purposes, adapted to a road roller, fitted with solid-tired wheels and buffers front and rear for shunting purposes in railway sidings, as a haulage tractor fitted with pneumatic tires, and as a roadless tractor fitted with a winch and suitable for timber felling and hauling. The general features of this tractor are already well known to readers of THE ENGINEER, but numerous improvements in details have been effected. For instance, there is a larger radiator, which gives 91·5 square inches of extra cooling surface. It is longer and deeper and round-gilled tubes have been replaced by square gilled tubes. The system holds approximately the same quantity of water. The fan and impeller are now arranged upon the same spindle and are driven by a "V" type belt, provision for adjustment being made by means of an eccentric bush. A new type of scraper which is rigidly attached to the mudguard and braced across the rear of the tractor is available. This scraper, it is claimed, effectively cleans the wheels no matter what type of land the tractor may be used upon. The mudguards have been strengthened and, at option, can be obtained with wings overhanging the wheels so as to afford greater protection from dust, and, in addition, further safety to the driver. The valves of the engine have been enlarged in size, thus considerably increasing the volumetric efficiency. The engine has more power and is still available as a petrol or paraffin machine. Finally, an alteration has been made in the induction pipe and vaporiser which has given increased power.

KERR-STUART HEAVY-OIL ENGINED LORRY.

The application of the heavy-oil type of engine to industrial traction has not made the headway to which its merits entitle it, and it is, therefore, interesting to report that more British engineers are now devoting some attention to this subject. The latest

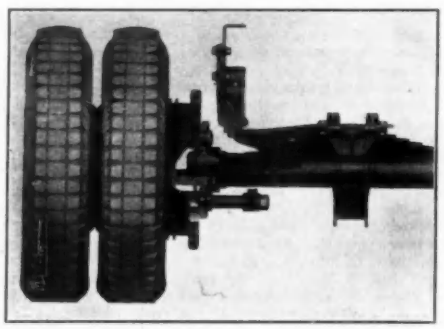


FIG. 4—SPRING ARRANGEMENT OF LORRY—KERR, STUART

introduction is that made by Kerr, Stuart and Co., Ltd., Stoke-on-Trent, the well-known locomotive builders. This firm will show two lorries propelled by Diesel engines capable of generating 72 brake horse-power. The lorries have other features of note besides the engines, the principal of which is, perhaps, the method of spring suspension for the rear axle. This system of "enharmonic" springing makes use of the difference in the natural rates of oscillation of two springs to minimise bouncing. A view of this lorry is given in Fig. 3. The engine is of the four-cylinder, four-stroke type, the cylinders, which are 135 mm. bore and 200 mm. stroke, having tough cast iron liners which are renewable when worn. The valve gearing is of the overhead type and is operated through a camshaft, running in the top of the crank casing, by push-rods and overhead rocker arms. The separate oil pumps to each cylinder are positively-driven from the timing gear and are carried on the side of the engine in an accessible position. They are fitted with hand-operating gear to enable the pumps to be flushed. Atomisers of the spring-closed type are fitted in the heads of the cylinders and they spray into a pre-chamber which is retained at a higher temperature than the cylinder. Each atomiser is fitted with a hand-operated by-pass and tell-tale, so that the working of the pump can be watched at any time. The compression ratio is 14 to 1.

Engine power is transmitted from behind the clutch to the gear-box by means of a short propeller shaft, fitted with Hardy-Spicer fabric joints at either end. The gear-box contains four speeds and reverse, the ratios being: Top, 4·4 to 1; third, 7·94 to 1; second, 14·78 to 1; bottom, 29·35; reverse, 27·8 to 1. The top gear is direct and the final reduction is by means of steel worm and phosphor-bronze worm wheel. The differential is carried in the centre of the worm wheel and is lubricated from the gear-box. The final transmission is by silent roller chains, 2½in. pitch, from a sprocket at either side of the gear-box to a chain-ring on the brake drum, of each back wheel. The chains are oversize, and, since the bulk of the reduction takes place in the gear-box, the sprockets are large, so that chain wear is reduced to an insignificant amount. The controls follow normal petrol-lorry practice, but there is an extra control to enable the compression in the engine to be released, and further controls for the starting engine. The latter is a 4 H.P. petrol engine, air-cooled, with coil ignition, driving by means of a chain to a gear-box contained in a friction ring, which can be brought into frictional contact with a set of grooves in the main engine fly-wheel for starting up. The capacity of the fuel tanks is 20 gallons and the fuel consumption averages, we are informed, 10 to 14 miles per gallon of crude oil. With the engine running at 800 revolutions per minute the top speed is 20 miles per hour. Referring to the method of spring suspension, of which an illustration is given in Fig. 4, it will be seen that the two rear springs of the lorry are carried athwart the chassis, one being alongside the rear axle and forward of it, and the other in a similar position to the rear. The axle is constrained to move in the arc of a circle by means of radius rods which serve to hold the rear wheels at an unvariable distance and to allow of chain adjustment when necessary. The two springs have the same rate, *i.e.*, they deflect an equal amount for an equal load, but, in action, the forward spring will be compressed a lesser distance than the rear one, since the former is nearer the radius rod centre than is the latter. The makers claim that the effect of this arrangement is to shift the harmonic curves of the two springs out of synchronism, so that damping occurs. The effect is like that of a shock absorber, but it does not interfere with the freedom of the springs and a very smooth running vehicle results.

MARSHALL, SONS AND CO.

This firm's exhibit will cover an extraordinarily wide range, including agricultural, industrial, power, road-making, and building machinery. The vertical

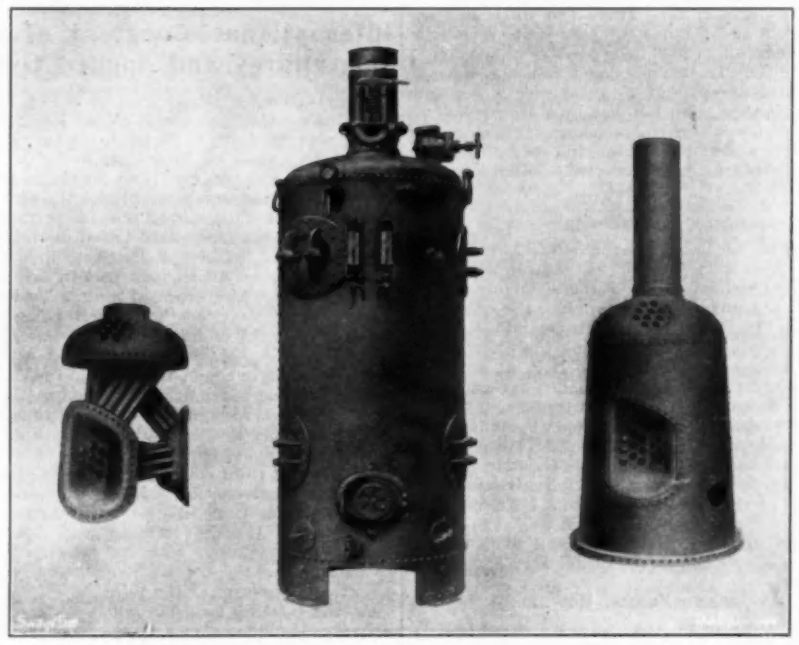


FIG. 5—VERTICAL WATER-TUBE BOILER—MARSHALL

water-tube boiler illustrated by Fig. 5 is made in six sizes, from 3ft. 6½in. diameter and 82 square feet of heating surface to 6ft. diameter and 300 square feet of heating surface. The boiler shell is made of steel plates, and the internal fire-box is connected to the crown plate by an uptake of extra thickness. The fire-box is intersected by six groups of water tubes, the three upper groups being inclined at an angle of 45 deg., while the three lower groups are placed in nearly horizontally. The upper groups cross each other at mid-incline and are expanded at their top ends into flattened surfaces pressed in the fire-box crown plate. At their bottom ends they connect with other pressings which are riveted to the fire-box and also form the connections between the lower tube groups. Any of the tubes can be withdrawn when necessary through openings provided in the external shell. The ashpit is formed by an extension of the lower part of the boiler shell and a suitable opening is provided under the fire-door for the clearance of

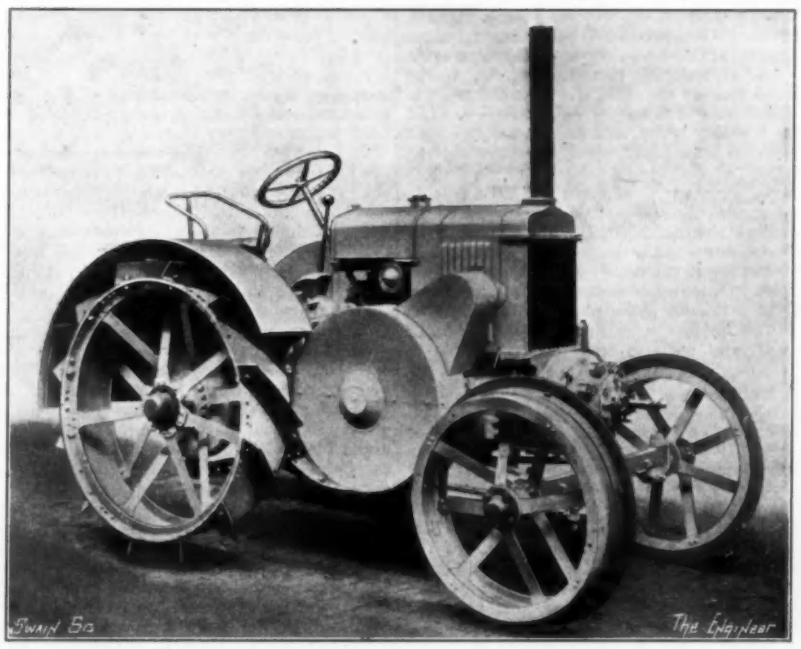


FIG. 6—HEAVY-OIL ENGINED TRACTOR—MARSHALL

ashes. It will be seen from the illustration that the heating surface is large and the groups of water tubes are placed where the hot gases have the fullest effect. The inclination of the tubes causes an active circulation of the water and quick steam-raising results. Another good feature of the boiler, which is built for a pressure of 120 lb. per square inch, is the accessibility of its internal parts for cleaning purposes. Other exhibits by this firm will include steam and oil-driven traction engines and road rollers, oil engines, portable steam engines, concrete mixers and thrashing machines with both wood and steel frames. The heavy-oil engined tractor, of which we give an illustration in Fig. 6, is quite new, and has been designed on the simplest possible lines. The engine has a single-cylinder, 8in. bore by 10½in. stroke, and its power rating on the belt is 30 horse-power at 550 revolutions per minute. There are three forward speeds—1¾, 3 and 5 miles per hour—and a reverse, and a drawbar pull of 2800 lb. is possible when ploughing in low gear. The tractor has a radiator, fan and cooling water pump, and its total weight is about 2½ tons. Neither lamp not hot bulb is required to start the engine. The Universal steam road roller, with its articulated main axle, the oil-driven road roller, and concrete mixers are fully familiar to our readers.

PETER BROTHERHOOD.

The exhibit of Peter Brotherhood, Ltd., in the machinery-in-motion section, will consist of a two-cylinder Brotherhood-Ricardo Diesel engine direct-coupled to a Laurence-Scott dynamo, the output of which is 50 kW at 750 revolutions per minute. The set will be working on load during the Show. The engine is designed to develop 100 H.P. at a normal speed of 900 r.p.m. This engine has several novel features of design, the most important being that a single sleeve replaces the usual poppet valve mechanism. The makers point out that, besides being simple, the single sleeve allows of complete freedom in combustion chamber design, and that full advantage has been taken of that fact to produce a cylinder head, giving a very high degree of turbulence so as to ensure complete combustion of the fuel, and to permit of the use of a simple single jet injector nozzle.

JAMES AND FREDK. HOWARD.

This firm will have two stands, one devoted to locomotives and railway equipment and the other to agricultural implements. On the former stand will be shown a 3-ton petrol locomotive, representing a range of from 2 to 12 tons. It is fitted with a 25 H.P. four-cylinder petrol engine and is arranged for a 24in. gauge track. Features of this engine are (*a*) a strong locomotive type frame; (*b*) the engine and gear-box are mounted as a unit on a sub-frame; and (*c*) there is a single-lever control for the gear-box. The transmission is fitted with ball and roller bearings throughout and the roller bearing axle-boxes are provided with an excentric chain-tightening device, which enables a semi-skilled man to adjust the chain tension in a few moments. The locomotive will be shown on a 60ft. length of portable railway track with 14 lb. per yard rails upon steel sleepers. On the agricultural implement stand will be seen new designs of two-furrow and three-furrow self-lift tractor ploughs. Although similar in many respects to the older Howard tractor ploughs, the new pattern has been improved and is designed to face the hardest work. The self-lift device is a simple arrangement which raises the implement out of work, when the tractor driver pulls a cord, a further pull causing it to drop back. Another implement will be a tractor mole drainer. A number of cultivators will be included in the Howard exhibit, one of them being the "Dragon" self-lift tractor cultivator, with special spring-tyne boxes which ensure the thorough breaking up of the soil. Other implements, new to the Royal Show, will be a flexible grass harrow and a tandem disc harrow. The former is fitted with tripods of greater length and with sharper points than upon previous designs. The links also are stronger to withstand the greater drag caused by the long tripod points.

BARFORD AND PERKINS.

Important developments made in motor road rollers during the past year will be reflected in the heavy-oil roller which will be shown by Barford and Perkins, Ltd., in the machinery in motion section. Water ballast rolling wheels are fitted, the weight of the roller, without extras, being 10½ tons unballasted and 12½ tons with water ballast. The power unit is a 32–35 B.H.P. two-cylinder Diesel engine, mounted with the gear-box on a sub-frame giving great accessibility and bringing the centre of gravity down to below the axle line. Three speeds, of approximately 3¾, 2½ and 1¼ m.p.h. in both directions, are provided, and quick-reverse clutches operated by a separate hand lever are fitted. All the gearing is totally enclosed and runs in an oil bath. The hand steering gear is by worm and quadrant. Amongst the extras to be fitted to the roller exhibited is a power steering gear operated entirely independently of the hand steering. This roller is designed for any road rolling duty demanding a machine of approximately 10 tons. The cost of fuel and lubricating oil is stated to be approximately 2½d. an hour, actual rolling time.

Another exhibit on this stand will be a 4-ton petrol roller, type "B.K." It is of three-wheel design and is intended for patching light road work both in this country and abroad. It is equipped with a four-cylinder engine of 13·25 B.H.P. and has two speeds of 3½ and 1¾ m.p.h. in forward and reverse. Its rolling width is 4ft. 6in. and it is said to give a rolling compression equivalent to that of a 6-ton tandem roller. It is fitted with a differential gear and a quick-release draw-bar, which enables the driver to release a hauled unit without leaving his seat. Thus, the roller can be used with safety in conjunction with a tar boiler, since, in case of fire, the boiler can be released and the roller can be driven quickly away.

(To be continued.)

International Congress of Mines, Metallurgy and Applied Geology.

THE International Congress of Mines, Metallurgy and Applied Geology, which closed last Saturday at Liége, was the sixth of its kind, the previous session having been that at Düsseldorf in 1910. Since up to the present there has been no permanent International Committee responsible for the arrangements for successive Congresses, the Liége meeting was organised by the Liége Association of Engineers and the Geological Society of Belgium, in consultation with the societies which took part in the Conference at Düsseldorf. Liége formed an admirable meeting-ground for the Congress, not only as being one of the principal centres of mining and metallurgy on the Continent, but because of the added attraction of the Exhibition in commemoration of the centenary of the constitution of the Belgian kingdom. The Congress received official recognition by the patronage of King Albert and the Belgian Government, and was supported by delegates from twenty-one different countries and from many scores of technical associations and universities. More than a thousand members took part in the proceedings, Belgians, French, and Italians forming the vast majority, though this country, with its fifteen official delegates and numerous private members, contributed a noticeable fraction of the total.

At the opening meeting, which took place in the Salle Académique of the Liége University on Monday, June 23rd, Professor P. Fourmarier was elected General President of the Congress. The latter was divided into three sections, corresponding to the three elements of its title, each section having its own meetings and also making excursions and visits to works of peculiar interest to its own members. The papers submitted for discussion numbered 213 in the aggregate. There were 97 in the Metallurgical Section, while the sections concerned with mining and geological questions contributed 58 each. Of the total, less than a dozen were submitted by British authors. The papers themselves were not available at the time of the Congress, official summaries forming the basis of the discussions. Unfortunately, even the summaries of many of the papers with promising titles were absent from the volumes comprising the matter to be dealt with by the several sections. It is permissible to believe that the fault in such cases lay rather with the tardiness of the authors than with the organising committee of the Congress, the arrangements for which were admirably carried out on the whole.

It becomes more and more evident to those who are familiar with international engineering congresses that the true value of these functions lies much more in the opportunities afforded for friendly meetings between the engineers of different countries, and the facilities afforded for visiting foreign works, than in the discussions, usually perfunctory, of an indigestible mass of papers attempted often in an almost tropical temperature, and made more difficult by the multiplicity of mother tongues. The organising committee of the Liége Congress was fully alive to this fact, and saw that nothing which time and circumstances permitted was wanted for the social and visual entertainment of the visitors. The main features of a non-technical nature were a reception and ball given by the Burgomaster and Echevins of Liége at the Palais des Fêtes of the Exhibition; the performance of "L'Amant Jaloux" by the Liége composer Grétry, at the Theatre du Gymnase; a reception and tea given by Monsieur and Madame Jacques Van Hoegaerden at their historic Chateau de Modare, in the Ardennes; and, of course, the Congress Banquet. Many members of the Metallurgical Section combined instruction with pleasure by visiting the famous works of John Cockerill at Seraing, lunching there by invitation of Monsieur Léon Greiner, the managing director. Others inspected the laboratories of the Fabrique Nationale d'Armes de Guerre, at Herstal, a firm as well known for its motor cars, motor cycles, and bicycles as for its production of firearms. The works of the Société Metallurgique de l'Esperance-Longdoz and the load transmitting station of the power company of the Liége area were also visited.

The Mining Section inspected the surface works of the Wérister Colliery, the underground workings of the Maurage Colliery; the power station and winding engines of the Monceau Fontaine Colliery; the surface works of the Hensies-Pommeroeul Colliery; the Campine Collieries of Limbourg-Meuse, André Dumont, Winterslag Beeringen, &c.; finally seeing the works in connection with the sinking of a shaft at the Houthalen Colliery by the freezing process.

The Section of Applied Geology started its sight-seeing on the Friday before the Congress opened by visiting the geological exhibits at the Antwerp Exhibition. The next day it saw the Beeringen and Zolder Collieries, and on the Sunday enjoyed an "excursion d' hydrologie" at Spa. Later in the week it visited the iron mines of Couthuin, some quarries in the Meuse Valley, the manganese mines in the Valley of the Lienne, the mineral springs of Chevron, the slate quarries of Vielsam, &c.

Some of these visits took place after the official closing of the Congress on the morning of Thursday, June 26th, but even so, it will be evident that the week was well filled with events, either in the halls of the University or in the more enjoyable open country. At the closing meeting it was decided that a permanent Committee should be established to arrange for future Congresses of the kind, and that the next Congress should be held in Paris in 1935. Tribute was rendered to the services of Professor Fourmarier, not only as President of the Congress, but also as President of the General Organising Committee, who had made the arrangements. A kind and well-deserved reference was also made to the work of Monsieur O. Lepersonne, the secretary of the Liége Association of Engineers, to whose efforts and personality the success of the Congress was so largely due.

Sydney Harbour Bridge.

BY the courtesy of the Official Secretary at Australia House, of the Commonwealth of Australia, we are enabled to reproduce on page 12 two photographs which have just reached this country and which show the progress made to within a few weeks ago with the Sydney Harbour Bridge.

Our readers will remember that this bridge, which is being built by Dorman, Long and Co., Ltd., will have a single central arch, with a span of 1650ft.—by far the largest in the world—and a total length with its approach spans of 3770ft. Its total width is to be 150ft., and there will be a minimum head room below the substructure of the flooring of 170ft.

In our issue of March 7th, 1924, we gave a reproduction of a drawing, showing the appearance of the structure when it is completed, and in our issue of October 28th, 1927, we gave an illustrated description of the crane equipment which was to be used in its erection and which was supplied by the Wellman Smith Owen Engineering Corporation, Ltd. One of the views shows clearly this equipment in service.

SIXTY YEARS AGO.

SIXTY years ago the Pacific Railway had just been completed and opened to traffic. To the traveller across the Western States of America it afforded for the first time a means of journeying alternative to the pony express, the covered wagon or the voyageur's canoe. Adventure did not, however, disappear with its construction. It had been built in the face not only of great natural difficulties and the rivalry of conflicting interests, but of active hostility on the part of some of the native tribes. The Indians frequently raided the working encampments and isolated stations, and when the line was completed were, on occasion, bold enough to attempt the holding up of a passing train. An accident of the kind was reported in our issue of July 8th, 1870. A telegram from Salt Lake stated that on June 15th the driver of a train approaching the Platte River discovered a band of three hundred Indians crossing the line. As the train came near them they emitted loud yells. The driver, believing that they were about to attack the train, put on full steam and dashed through the band at high speed. Thirteen of them were killed. No information was given in our note as to the identity of the Indians. If they were Blackfeet, or Crows, as they might well have been from the locality of the incident, the driver was probably right in his interpretation of their intentions, for these tribes, particularly the Blackfeet, were daring warriors as well as thieves. If, however, they were Shoshonies, or Nez Percés Indians, or members of several other possible tribes, their intentions were probably peaceable, their clamour at the approach of the train being characteristic of an Indian welcome. Readers of Washington Irving's "Astoria" and "The Adventures of Captain Bourneville," will recall that the early explorers and trappers in the Western States were repeatedly guilty of attacking natives whom they thought to be hostile, but who in reality were quite peacefully disposed. In 1832, for instance, a party from Captain Bourneville's expedition found a large band of Snake Indians assembled at a river crossing. The trappers and hunters were convinced that the natives meant mischief, and without waiting to parley fired a volley into their midst Many were killed and the rest fled. The Snakes were a poor-spirited nation, downtrodden by other tribes and anxious to have the white man's friendship and protection. Events of this nature generated a bitter spirit of revenge on the part of the natives and were frequently the origin of apparently unprovoked outbreaks of bloodthirstiness. That the Indians of 1870 still retained the revengeful characteristics of their fathers may be inferred from the fact that the incident on the Pacific Railway was regarded as likely to endanger peace on the border and to react on the safety of the line.

AN aeroplane base for surveying purposes is to be constructed at Fort Resolution, Northern Canada.

Railway and Road Matters.

THE "Flying Scotsman"—10 a.m. from King's Cross to Edinburgh and 10 a.m. Edinburgh, Waverley, to King's Cross—will resume its non-stop run between those respective points on Monday next, July 7th.

RECENTLY 1629 wagons were dealt with in 1096 "cuts" at Whitemoor gravitation marshalling yard—March, L. and N.E.R.—in one shift of 8 hours. The previous best record was 1375 wagons.

ACCORDING to the answer to a question addressed to the Minister of Transport, it appears that at the end of last year the proportion of passenger stock lighted by gas was 44 per cent., as compared with 47 per cent. at the end of 1928.

A REPORT from Cairo states that the Egyptian State Railways will shortly invite tenders for the supply, delivery, erection and maintenance of an electric power station near Cairo. The initial plant is to comprise two 1250 kilowatt turbo-alternators with water-tube boilers, switchboard, transformers, pipework and other accessories and overhead cranes.

SOME details of the reconstruction of Leicester-square station were given on page 633 of THE ENGINEER of June 6th. The Underground Railway authorities now state that the reconstruction of Dover-street, Hyde Park Corner and Knightsbridge will follow. A feature will be entrances on each side of the main street, so that there will be no occasion to cross the road to get to or leave the station. Dover-street will, for instance, have one entrance at the Green Park side of Piccadilly and Hyde Park Corner one on the Park side.

THE conversion to electric traction of all its lines in the London area will be completed by the Southern Railway on Sunday next, July 6th, when the electrical services will be extended to Windsor, also from Dartford to Gravesend. The branch between Wimbledon and Croydon was not converted when the other lines in that vicinity were done two years ago, but it is now completed. Two new stations are being opened—Whitton, between Twickenham and Feltham, and North Sheen, between Mortlake and Richmond. The total length of line converted is now 800 track miles.

DURING the nine months ended on September 30th last, the assistant inspecting officers of the Ministry of Transport held 136 inquiries into the more serious accidents to railway servants. Of these, 52 inquiries related to fatal accidents and covered 54 men. As usual, the greater part of the fatalities occurred among permanent way men, of whom 23 were killed; the next rank to suffer the most was that of the signal fitters, of whom six were killed. Whilst it is significant that 24 of the deaths were ascribed to want of care and 17 to misadventure, it is more noteworthy that in eight cases there was no look-out man and in another instance the look-out was insufficient.

IN September next, Mr. R. H. Tatlow retires from the position of publicity manager to the South African Railways, and on May 24th sailed for England on leave prior to retirement. Mr. Tatlow deserves a notice in these pages, partly because of the magnificent work done in this country, the United States, and elsewhere to make the wonders of South Africa known and partly because he initiated and, for 25 years, edited the *South African Railways and Harbour Magazine*. He comes of old railway stock. His father was Sir John Aspinall's accountant at Horwich; an uncle was on the Midland Railway; but his best-known relative was Mr. Joseph Tatlow, for many years the general manager and, later, a director of the Midland Great Western of Ireland.

THE annual review of the standard rates and charges by the Railway Rates Tribunal, mentioned in this column on June 6th, resulted in judgment on the 20th of that month, that there should be no modification. It was said that the year 1929 had been a difficult one for both traders and railways, both being engaged in a struggle to regain or recapture traffic which they had lost, or were in danger of losing, to competitors. Proceeding, the judgment remarked that for the railways the evidence showed that their efforts had been in the direction of maintaining and increasing facilities and, at the same time, reducing the cost of them by provident and timely re-organisation. The conclusion was "that nothing appearing under our review which established that under present conditions any modification or modifications would enable the companies to earn their respective standard revenues, no such modifications are necessary and we make none."

THE circumstances that led to the collision of January 8th last near Stapleton-road, Bristol, Great Western Railway, mentioned in this column on January 17th, were inquired into by Lieut.-Colonel Mount, whose report thereon has been recently issued. It is therein shown that the "accident was really the outcome of loose block working, which had grown up and was admittedly being allowed by these men—the signalmen in the adjoining boxes of Stapleton-road and Lawrence Hill—to pass without notice. This seems to me to be the important feature of the case." Three trains were concerned; the first was a freight train which was correctly "cleared" by signalman Toop, of Lawrence Hill and the next was another freight train which, apparently, was duly signalled forward by Love, the man at Stapleton-road, but not indicated on the block instruments by Toop. The third was the passenger express, and when Love asked Lawrence Hill why he had not "cleared" the second train, that man did so and Love then offered the express, which was accepted, though the second stood at the Lawrence Hill signals. A collision resulted. Both men had been guilty of loose block working, *e.g.*, the man at Stapleton-road used to permit trains to go towards Lawrence Hill without notification. Another feature was that, although there was a board at Lawrence Hill instructing drivers to draw up to the home signal, the driver of the second train came to a stand 291 yards in its rear because some point rodding might have impeded his guard's progress. Colonel Mount recommends that the rodding be boxed in and that track circuit be provided. It is not without interest to note that irregular block working was the cause of a similar collision at Stapleton-road on December 23rd, 1904.

Notes and Memoranda.

THE direct loss through fires in Great Britain and Ireland amounted last year to approximately £8,000,000.

THE production of ammonium sulphate as a by-product in Canada increased by 21·5 per cent. last year. The total production was 34,141 tons.

THE first hydro-electric plant in Saskatchewan has just started work at Island Falls. It is of 44,500 horse-power, and is transmitting to the Flin Flou mining area at a pressure of 110,000 volts.

A CANAL across the Strait Peninsula has been proposed to the Siamese Government by a group of Danish, German, and Dutch engineers. The length of the proposed canal would be 32 miles, and its construction would shorten the distance from Ceylon to Hong Kong from 3040 to 2430 miles.

THE world production of silver for the entire period from 1493 to 1927 inclusive has been over 14,000,000,000 ounces, or about fourteen times the weight of gold produced in the same period, according to the United States Bureau of Mines, Department of Commerce, which has conducted an economic survey of the subject.

FOUR hydro-electric power plants in Styria, a province in Austria, are under contemplation, according to the *Engineering News-Record*, and the promoters are negotiating in New York for a loan of 10,000,000 dollars for their construction. The plan is for the Government to contribute 1,000,000 dollars. An American commission will investigate the projects before deciding whether the loan will be granted.

ONE span of an old bridge across the Main River at Klingenburg, Germany, was accidentally destroyed recently during the construction of river regulating works. A pile driver was being erected on pontoons in the river below the bridge and a steel cable had been made fast to the bridge railing to be used in raising the leads of the driver into position. During the hoisting the entire span gave way and fell on the pontoons, killing one man and slightly injuring five more. The entire bridge of five spans will be replaced by a new structure, as it had been considered inadequate for some time.

TWO new steam turbo-generators, each of 160,000 kilowatts capacity, will be installed in the Hudson-avenue station of the Brooklyn Edison Company during the next two years, according to Matthew S. Sloan, president of the New York Edison and affiliated electric companies. Tenders have been asked for these units, which will raise the capacity of the Brooklyn station to 770,000 kilowatts. When these generators are in service the Hudson-avenue station will have a total capacity larger than the present capacity of 810,000 horse-power at Hell Gate, which is now the largest steam plant in the world.

POLAND'S zinc industry occupies the third place in the world's production of this metal, after the United States and Belgium, and the second place in Europe. The Polish output represents about 11 per cent. of the world's total. The Polish industry enjoys more favourable conditions than does that of Belgium, in so far that in addition to the great wealth of coal it has on the spot an abundance of ores amounting to about 80 per cent. of the requirements. The Polish industry is one of the oldest in Europe, for zinc smelting was begun more than 130 years ago. The main centre of production is Upper Silesia, which supplies about 85 per cent. of the total output of the country.

IT is reported that Mr. W. H. Pritchard—School of Physiology, Middlesex Hospital, London, W.—has recently designed an apparatus for detecting the presence of various kinds of gases. The principle upon which the apparatus works is, roughly, electro-chemical, and necessitates a specific but common liquid reagent for the detection of each individual gas. Hence the device is claimed to be selective, and cannot be operated by any other gas than that it is set to detect. Further, it indicates the quality and quantity of any gases, in most cases below a strength of 1 part in 1000 parts of air, and in all instances of toxic gases the device will automatically and almost instantaneously record their presence in quantities far below the accepted minimum likely to be dangerous to human life.

DURING 1929 a total of 344 million large tungsten-filament lamps were sold in the United States, according to a report of the Lamp Committee of the National Electric Light Association, which has just been published. This is the greatest number of lamps every sold in any one year, and represents an increase of 8·7 per cent. over the previous year, as compared with a 3·8 per cent. increase in 1928 over 1927. More than 15 million carbon lamps were sold during the year, as compared with 12 million sold in 1928, of which 88 per cent. were imported. These figures do not include miniature lamps, such as those used in flash-lights, automobiles, and for decorative purposes, of which nearly 260 million tungsten filament and 19 million carbon filament lamps were sold, the largest number being for use on automobiles, which totalled 138½ million.

RECENT use of the nitridation process for providing an object made of steel with a hard surface or "case," has made it important to know how hard and how thick the case may be and how brittle the specimen may have become. There are several indentation methods of measuring hardness; and by breaking the specimen it is possible to determine the thickness of the case and the brittleness. Another method has been devised by which, with the making of two hardness tests, the hardness can be determined from the first reading and the thickness from the difference of the two. The first measurement is made by the Herbert pendulum hardness tester, and the second by the well-known Brinell ball indentation method. In the June issue of *Mechanical Engineering*, Edward G. Herbert shows how closely the thickness of the case on various nitrided steel specimens, as measured by the process he describes, comes to that determined by measurement. He gives a table by which the differential of the two hardness readings may be converted into thickness of case. He also shows how thin or brittle cases can be detected by subjecting the surface to a "cloud-burst" bombardment of steel balls. Brittleness is shown by cracks; soft places and thin case by indentation.

Miscellanea.

THE Chenderoh Dam, the first stage of a £4,500,000 hydro-electric scheme to supply power to an important Perak tin mining area in the Malay States, was formally opened on June 28th.

THE value of the chemical products of Canada during last year amounted to 168,598,892 dollars. It is noteworthy that paints, soaps, fireworks and several other commodities, are included under the official classification.

THE Postmaster-General, in a written answer to a Parliamentary question, recently stated that the programme for the conversion of London's telephone system to automatic working contemplates the provision of 150 automatic exchanges before it is complete.

THE Royal Scottish Museum has chosen for its special exhibit for July a small collection of incandescent electric lamps illustrating the early successful efforts of that great pioneer, the late Sir Joseph Wilson Swan, and of his contemporary inventors, St. G. Lane-Fox and Thomas Alva Edison.

THE Transatlantic telephone invaded the Arctic Circle for the first time on Monday, when the service was extended to the entire telephone system of Sweden. It is now possible for Swedish users to call points on the other side of the Atlantic as far down as the Fortieth Parallel, South, in South America.

POORLY erected and unsightly wireless aerial poles are banned on the Bristol Corporation housing estate. To prevent damage to house property, tenants must submit aerial designs to the housing committee. The increased popularity of the portable set and the widespread use of H.F. stages, states the *Wireless World*, will soon render such regulations unnecessary.

ANSWERING Mr. P. J. Hannon in the House of Commons recently, the Foreign Secretary said that the Government could not object to the decision of the Abyssinian Government to construct a dam across the outlet of Lake Tsana, and could only defer to that Government's wishes when it selected the White Corporation of the United States to make a preliminary survey of the work.

TELEVISION experimenters who receive the daily tests from Witzleben, Germany, will be interested to learn that arrangements have been completed for similar tests from Koenigswusterhausen, which employs a power of 26 kW, as compared with 1½ kW of Witzleben. The present experiments are carried out from 9 to 9.30 a.m. and 1 to 1.30 p.m., except on Tuesdays and Thursdays, but it is probable that nightly tests after broadcasting hours will soon be started.

A MESSAGE from Toronto, dated June 25th, states that an address broadcast from a train moving at 60 miles an hour 100 miles away was heard there perfectly on the previous evening. The demonstration was given at a banquet of the American Institute of Electrical Engineers, and the address, which was delivered on board a Canadian National train, was clearly heard. Not only that, but the wireless transmission of reverse messages from the banquet hall to the train is said to have been carried out as smoothly as any ordinary telephone conversation.

THE "Platano," the turbo-electric cargo and passenger steamer, built by Cammell Laird and Co., Ltd., for Elders and Fyffes, Ltd., has returned to the Mersey after carrying out successful official speed and consumption trials. The speed was considerably in excess of contract requirements. The "Platano" is 415ft. long, with a breadth of 56ft., and a depth of 34ft., having a displacement of about 10,500 tons. The main electric propulsion equipment, supplied by the British Thomson-Houston Company, consists of one 5500-kW turbo-alternator, which supplies current to a three-phase synchronous motor. The vessel's cargo spaces are specially insulated for the carriage of fruit.

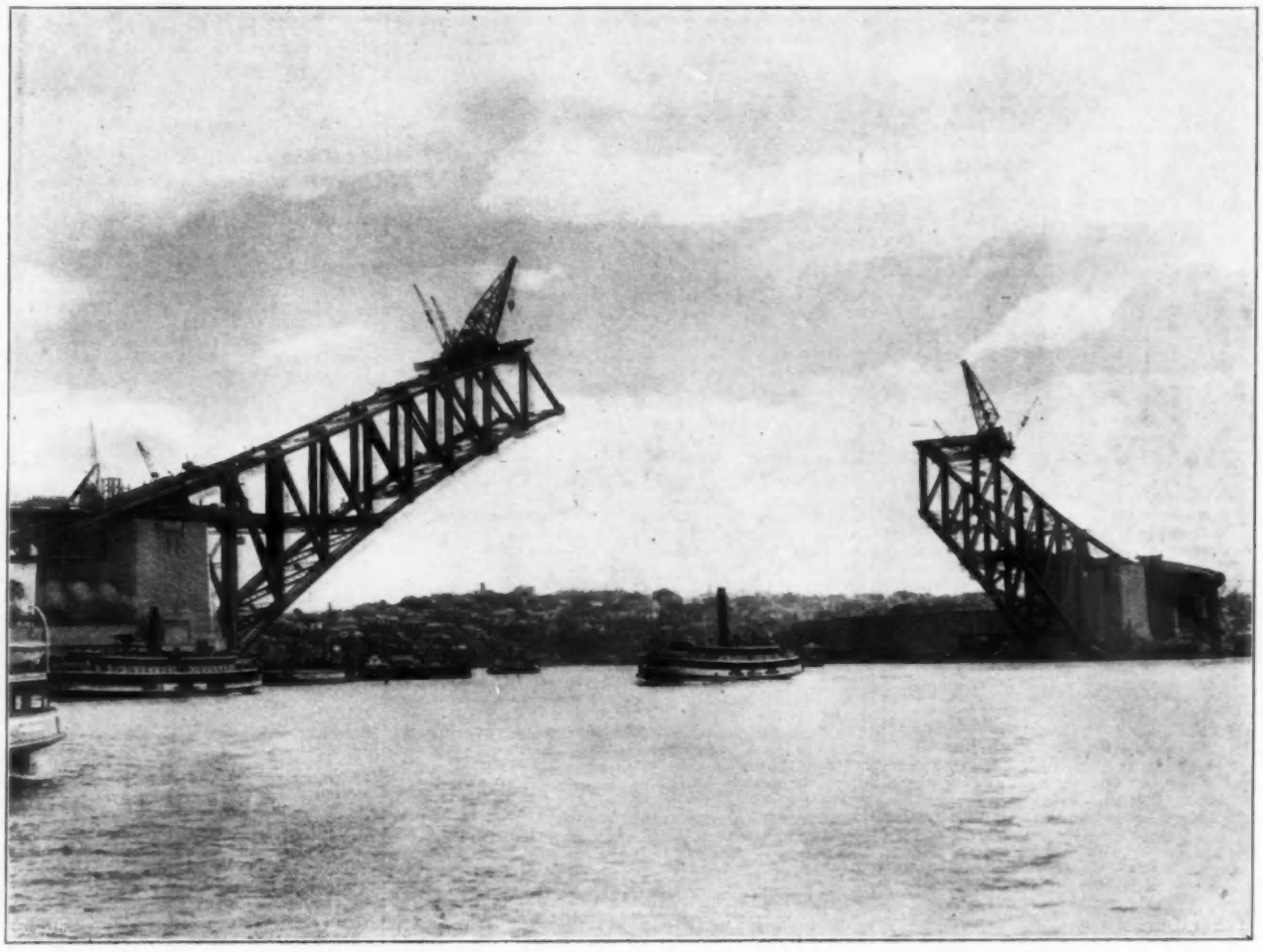
A MESSAGE from Ottawa states that orders have been placed in Great Britain for equipment for a new coal gas plant to augment the gas supply in the Vancouver district. The British Columbia Power Corporation, Ltd., proposes to extend its production during the next few years by 25,000,000 cubic feet a day. The first unit of this extension, with a daily capacity of 3,000,000 cubic feet, involving the expenditure of 750,000 dollars, will be built this year. The latest type of vertical retort plant will be installed, and, as the necessary machinery is not made in Canada, it has, therefore, been purchased in Great Britain and will enter the Dominion duty free, benefiting by the increased British preference announced in the Government's Budget this year.

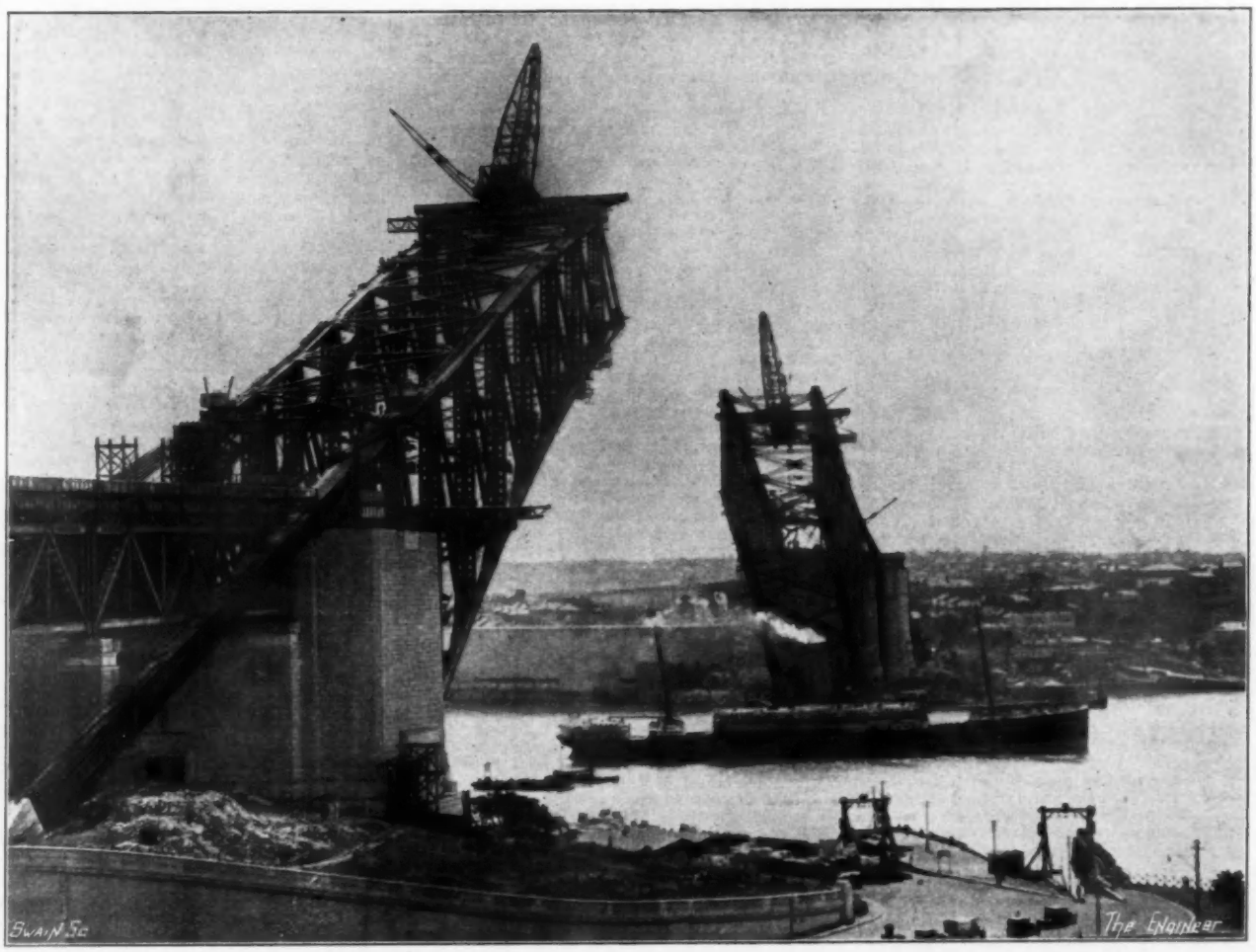
THE British Government recently proposed to the Belgian Government that a scheme of co-operation in mine safety research, similar to that arranged in 1928 between this country and France, should operate between Great Britain and Belgium. This proposal has been accepted, and arrangements are being made for a full interchange of information acquired by safety research in the two countries, including unpublished as well as published reports. A similar arrangement has recently been concluded between Belgium and France, and the circle of co-operation between the three countries is therefore complete. Full co-operation in mine safety research has been effective for the past six or seven years between Great Britain and the United States.

THOSE who require the services of a translator often experience difficulty in finding one who has both a knowledge of the language and also of the special subject concerned, and the difficulty increases when the language is uncommon and the subject highly technical. With the object of overcoming this difficulty the Council of the Association of Special Libraries and Information Bureaux recently appointed a committee to prepare a scheme for establishing a panel of translators, having both linguistic and technical qualifications, the part taken by the Association being to act as a connecting link between the translator and the user. Names of approved qualified persons are now being registered under the scheme adopted, and those who are interested, in either capacity, are invited to write for particulars to the Secretary, Association of Special Libraries and Information Bureaux, 26, Bedford-square, London, W.C. 1.

SYDNEY HARBOUR BRIDGE—SOME RECENT VIEWS

(*For description see page 10.*)





UNIV. OF

X-RAY CRYSTAL ANALYSIS

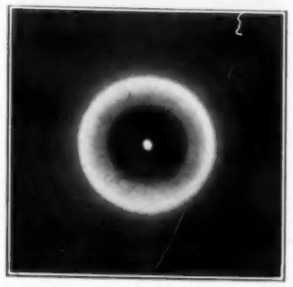


FIG. 13

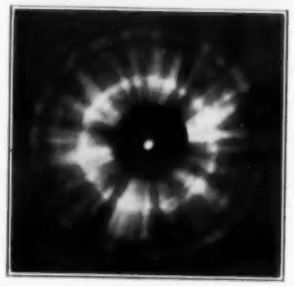


FIG. 14

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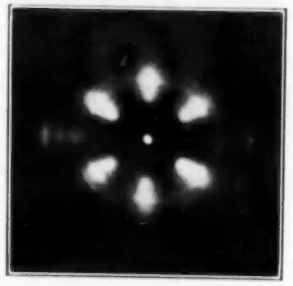

FIG. 15

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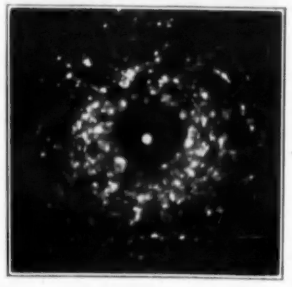

FIG. 16

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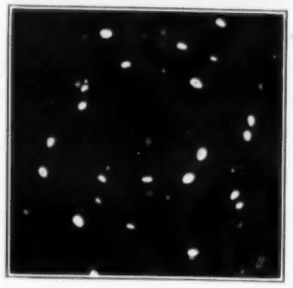

FIG. 17

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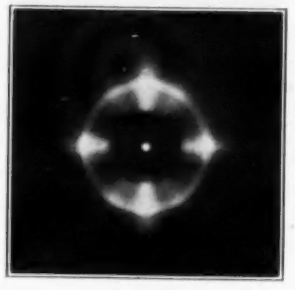

FIG. 18

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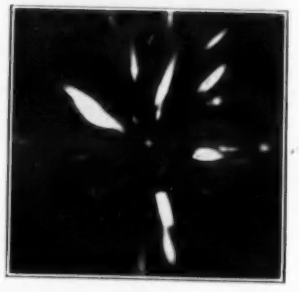

FIG. 19

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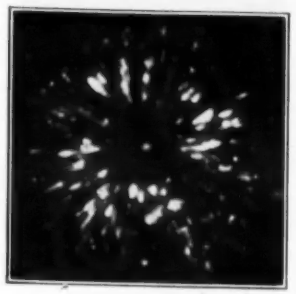

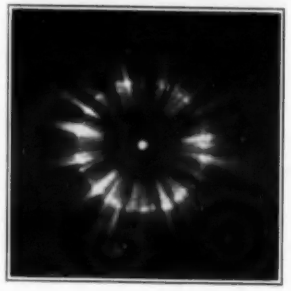

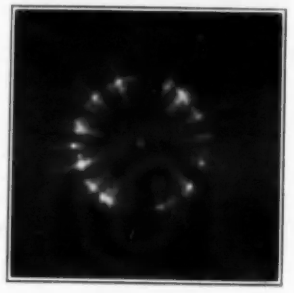

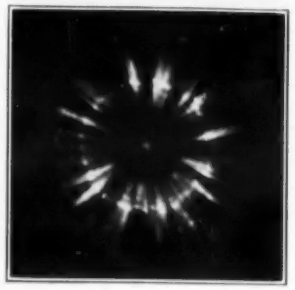

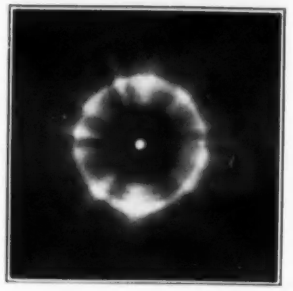

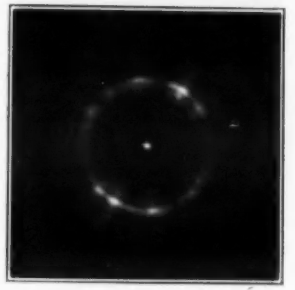

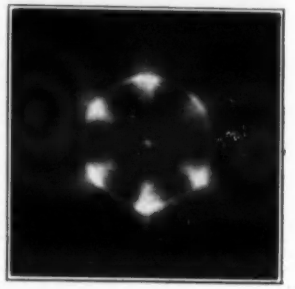

FIG. 20 (UNROLLED)

FIG. 21 (90%)

FIG. 22 (60%)

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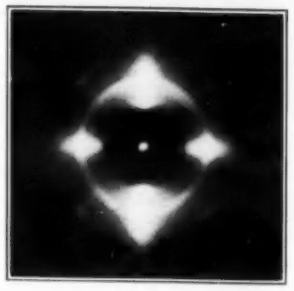

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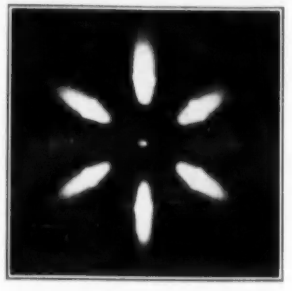

FIG. 23 (5%)

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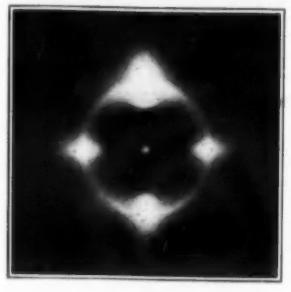

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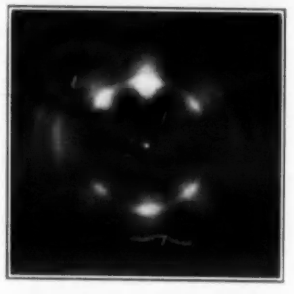

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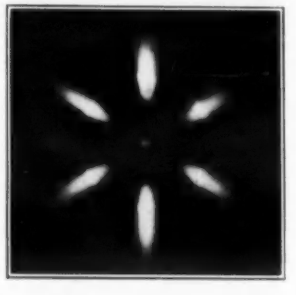
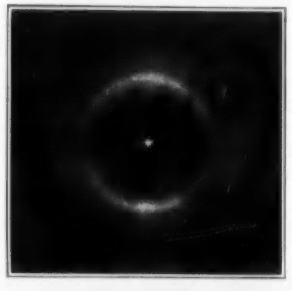


FIG. 24 (450° C.)

N

P



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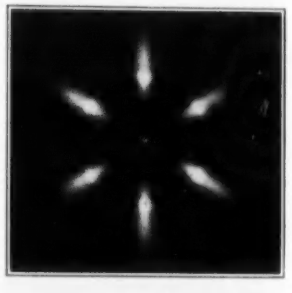

FIG. 25 (500° C.)

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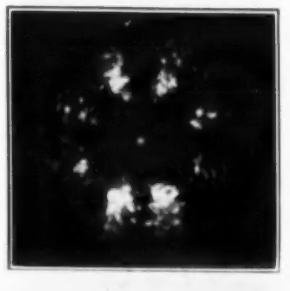

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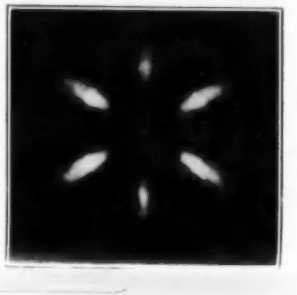

FIG. 26 (850° C.)

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N

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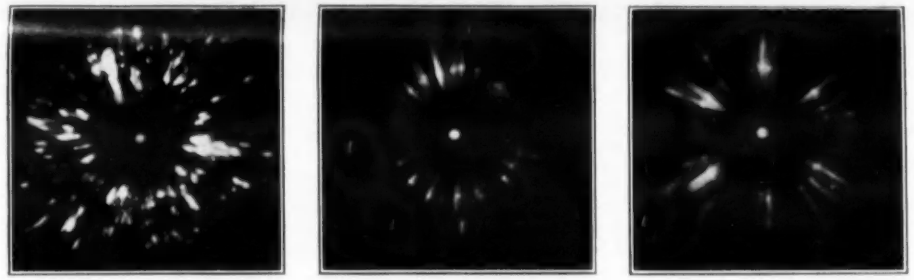

FIG. 25 (500° C.)

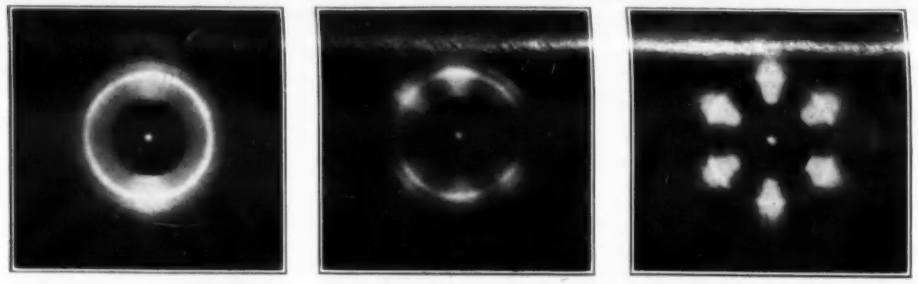

FIG. 26 (850° C.)

N P T

FIG. 27 (1050° C.)

FIG. 28—MANGANESE STEEL

N P T

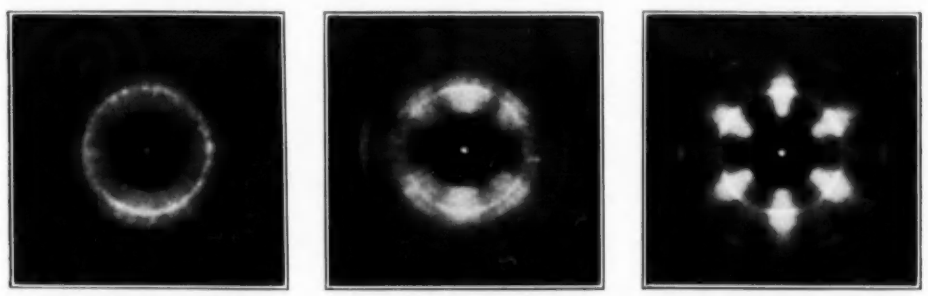

FIG. 29—MANGANESE STEEL (600° C.)

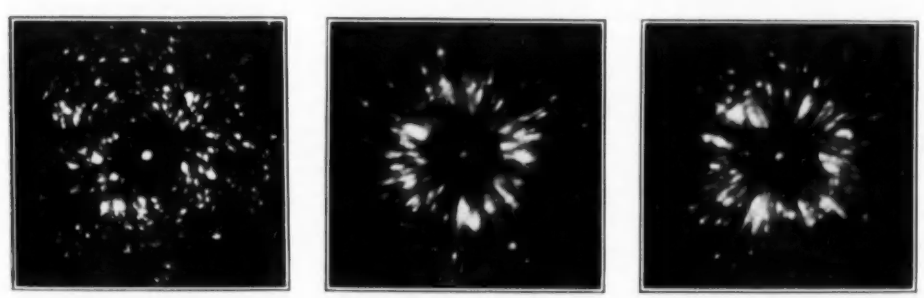

FIG. 30—MANGANESE STEEL (1200° C.)

N P T

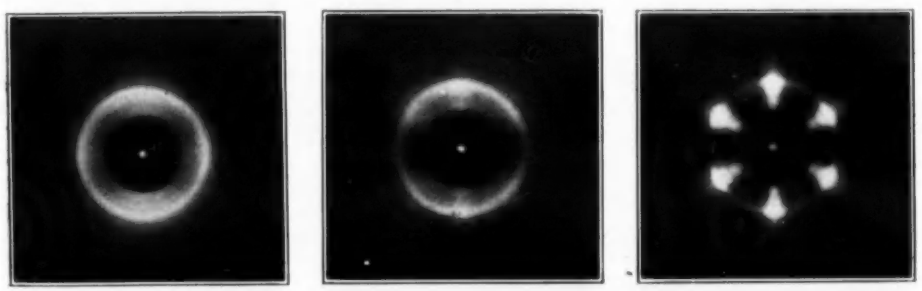

FIG. 31—STAYBRITE STEEL

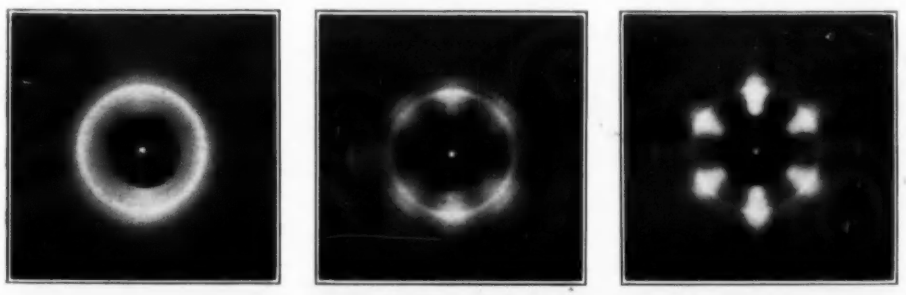

FIG. 32—STAYBRITE STEEL (600° C.)

A B

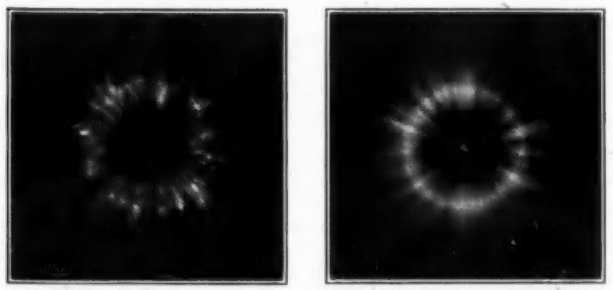

FIG. 33

C D

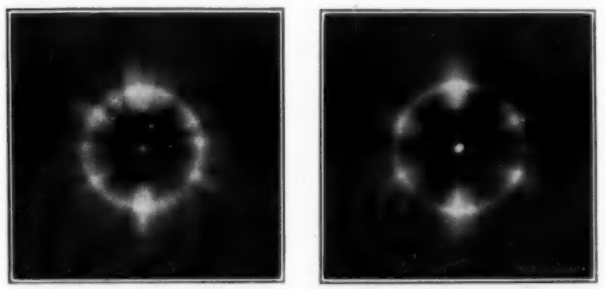

FIG. 33 (AT FRACTURE)

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THE ENGINEER.

VOL. CL No. 3886

JULY 4, 1930.

Conditions of Contract.

THE Association of Consulting Engineers has recently completed the preparation of a document bearing the title "General Conditions of Contract for use in Connection with Works of Civil Engineering Construction." The clauses embodied in the document have been for some time past the subject of discussion by sub-committees representing the Association and the Federation of Civil Engineering Contractors respectively. The conditions in their final form were accepted by the Council of the Federation at its meeting in May last and have been recommended for general use by both the bodies responsible for them. Attached to the conditions is a model form of agreement for civil engineering contracts. We believe that this is the first occasion on which a set of model conditions, designed specially for use in connection with civil engineering construction generally, has been agreed upon by responsible bodies representing both the engineer and the contractor. The Royal Institute of British Architects issued many years ago a model form of contract and conditions of contract which met with general acceptance by architects and building contractors alike. These documents have been revised from time to time, and we understand that a further revision is now being considered by the Royal Institute and representative bodies of building contractors. The model conditions issued by the Institution of Electrical Engineers for mechanical and electrical engineering contracts and the somewhat similar document issued a few years ago by the Association of Consulting Engineers are well known and in general use. A measure of general agreement has, however, for various reasons been more difficult to arrive at in the case of public works contractors and civil engineers. The recent agreement therefore may be regarded as a matter for congratulation, and is witness to the spirit of reasonableness which has evidently actuated those responsible for the drafting of the clauses and their acceptance on behalf of the contractors.

Although compromise is evident in some of the clauses, there does not appear to us to be any one clause in which the desire to compromise has resulted in the drafting of an unworkable or ambiguous condition. It is too much to expect that the conditions will please everybody. Some engineers, and possibly some contractors also, will discover conditions or phraseology with which they disagree or even, maybe, which they are unwilling to accept. But there does seem to be in the document a sound basis of agreement, and even if in some cases the document is not adopted in its entirety, many of the clauses will serve as valuable standards of comparison. Interest will chiefly be directed to the arbitration clause, which, in fact, is divided into two parts. The first—Clause 55—provides for the decision of the engineer in all cases of dispute and makes such decisions on certain limited subjects—for instance, the quality of the work carried out or materials supplied by the contractor—final and without appeal. But on any other matters of dispute, either the employer or the contractor has the right to appeal from a decision of the engineer to an arbitrator, and such arbitration cannot be opened until the completion of the works, except in a few special and limited circumstances—Clause 56. Subject to arbitration in the matters for which it is provided, the clauses as a whole have been drafted with the underlying intention that the engineer shall be free and unfettered in the exercise of the wide powers of authority, discretion, and decision which are given to him by the conditions. Any interference on the part of the employer with the discretion of the independent engineer contemplated by the document, except by way of appeal to arbitration, would place an employer in a dubious position in the event of a serious dispute. The conditions of contract are intentionally general; special conditions required for particular contracts or circumstances are obviously out of place in such a document, and no attempt has been made—we think wisely—to cover such subjects as, for instance, fair wages clauses. Other clauses, such as those dealing with the powers and duties of the engineer's representative or resident engineer, are capable of modification to suit the special circumstances of a particular contract—as, for example, in the case of work abroad when it may be desirable to confer special powers on the resident engineer. All essential conditions of a contract for civil engineering construction are, however, adequately covered by clauses which appear to us to be unambiguous and admirable in phraseology. The drafting committee has not been oblivious of the interest in archæological research which has developed in so marked a degree in recent years, for the clause dealing with articles of value or antiquity discovered in excavation, &c., makes every practicable provision for the proper treatment of archæological remains on discovery and before disturbance takes place.

Such a document as this is fills an obvious gap. Time will show in what manner revision is necessary, and there is nothing to prevent revision in the light of experience. While it is true that these conditions make arbitration more readily available, alike to employer and contractor, in the event of dispute in respect of all but the excepted matters, the fact that the document defines the rights of the parties in most circumstances that may arise, diminishes the likelihood of such dispute. In any case, if a dispute should occur, recourse to a technical tribunal is secured without reference to litigation in the courts.

An Avoidable Railway Accident.

A COUPLE of years ago British railways were in somewhat bad repute because of the apparent frequency of serious railway accidents. Actually the number of mishaps was quite normal, but the consequences were unusually serious. In 1927 more passengers were killed than in any year, except that of Quintinshill, since 1913, and the record for 1928 was higher than that for any year, again excepting 1915, since 1906. We maintained at the time that this bad record was purely fortuitous. We based that opinion on the fact that nothing had been done to affect the remarkable record of freedom from accident which this country enjoyed, and, later, when the report of the Chief Inspecting Officer of Railways was issued, we found support for our views in the fact that the Ministry of Transport had considered it necessary to inquire into fewer accidents in 1927 and 1928 than in any year since the war, except 1921. There is no better test of the safety of railway travel than the number of cases which the Ministry decides to investigate. Our conclusions that the number of fatalities two years ago was fortuitous is further supported by the fact that there was only one accident last year

in which passengers lost their lives, and that a period of fourteen months elapsed before the next fatal passenger train accident. The last-named accident should not have occurred. But men make mistakes, and despite all the provision made to prevent them, accidents happen. Yet it will come as a surprise to hear how frequently the Ministry of Transport officers' reports record that, if such and such a thing had been done or some apparatus had been provided, the accident would probably not have occurred. It is due to the companies, however, to say that as a rule it is only when the circumstances suggest that there was a weakness of that sort that an inquiry is held and that the number of inquiries is only about twenty a year. In the first three months of last year four accidents were inquired into. The first was the collapse of a privately owned overbridge and may be ruled out. The other three had fatal results. They were: January 8th, Ashchurch, two passengers and two servants killed; February 12th, Doe Hill, two servants killed; March 9th, Darlington, two servants killed. The Ashchurch collision would probably not have occurred had the more restrictive block working, since put into force, been in operation or, more important, had blocking-back been the rule as was recommended after the Hope accident of September 3rd, 1925, on the same system. At Doe Hill a signal was already in existence, but, says the report, "The special instructions issued by the company for working this box do not deal with this matter, but if he (the signalman) had tried to draw No. 25 lever (working the signal) he would have discovered his mistake and the accident would not have occurred." Again, at Darlington, "The accident is one which could have been prevented by suitably arranged track circuiting." Point is added to the last case by the fact that the signalman had to leave his box and cross four roads to reach a position from which he could see if a train was clear inside a siding. Finally, we come to the fatal collision of March 6th of this year at Culgaith, which was, we claim, avoidable.

Three factors mainly contributed to the Culgaith accident. The first was the way in which Rule 40 was observed. We need not quote the rule; suffice to say that in order to ensure that a driver shall not overrun a starting signal—*i.e.*, the signal beyond the signal-box—the home signal—that approaching the box—must be kept at "danger" until the train is close to the signal and has been brought quite or nearly to a stand. The lesson of the importance of that rule was taught to the Midland Railway by the disaster of September 2nd, 1913, at Ais Gill—20 miles south of Culgaith—when sixteen passengers were killed in a collision brought about by the driver missing the starting signal at "danger" after he had sighted the home signal in the "clear" position some distance before he reached it. The same company was responsible for the collision of July 29th, 1928, at Ancoats, and in his report thereon Colonel Trench definitely recommended an amendment to this rule. But our point now relates less to the observations of the regulation in question than to the way in which the signalman at Culgaith carried it out. He employed a regular landmark—a tree—and when a train arrived at the tree he pulled off the signal. But the tree was 200 yards from the home signal and therefore the train could not have been brought quite, or nearly, to a stand at that signal. Hence there was a serious misuse of the rule. It is further a question of rules that leads up to the second factor that contributed to the Culgaith collision. The starting signal was at "danger" and the guard should not have given the right-away hand signal. Colonel Trench says that "the signal was in full view from the platform" and that the guard "looked back along the train to see that all the doors were closed and then gave the right-away" to the driver without looking at the starting signal." Remarkable to relate, the man, under the rules, did no wrong, and all Colonel Trench can say is that it is very regrettable that he did not observe the indications given by the signal. The explanation is found in Rule 172, which says that "the signal to start given by the guard merely indicates that the station duty or the collection of tickets is completed." In that relation we may recall the Haverhill collision of November 29th, 1919. In that case the guard, under fairly similar circumstances, pleaded that, from where he stood, the view of the signal was obstructed by the station roof, and Sir John Pringle, in his report, said that the guard "could have obtained a view of the starting signal by walking ten yards forward along the platform. With so short a distance to move I think that most guards would have satisfied themselves as to the position of the starting signal before giving a hand signal to the driver." Why the rule should not be amended, so that the guard shall not give the "right-away" hand signal should the fixed signal be at "danger," we cannot say. That is the practice on the Underground. The only reason we can think of is that the passenger staff would then have to share an onus now entirely borne by the enginemen. The third factor is less easy. Colonel Trench does not say, possibly because it was too obvious, that automatic train control, applicable at the starting signal, would have prevented the collision. With such a remark we could not but have agreed, but it does not follow that a simpler remedy would not equally have met the case. From right back to the above-mentioned Ais Gill collision in 1913 we have been opposed to the automatic control of trains as something quite unnecessary in this country. Our views were related at length as recently as in THE ENGINEER of December 7th, 1928, when we claimed that a simple cab signal system is quite sufficient for the reliable type of driver British railways happily possess. The warning given by a bell or a whistle that they are approaching an adverse signal is all they need. They would at once be alert and on the watch and such accidents as the terrible one at Charfield and the less serious one at Ashchurch and now that at Culgaith would not have happened. Moreover, had such cab signalling been provided the last fatal passenger train accident would have been in October, 1928, nearly 1¾ year ago.

In conclusion, we may touch upon a more agreeable subject and one that appeals to all engineers. We refer to the good work done by the shock-absorbing buffers with which the first and third coaches on the passenger train at Culgaith were fitted. It is due to the memory of the late Mr. R. W. Reid to record that he, when carriage and wagon superintendent of the Midland Railway, designed those buffers, in order to minimise the possibilities of telescoping, after the Hawes Junction accident of December, 1910. On many an occasion since, has their worth been proved, and in the present accident the damage to the underframes of the first and third vehicles was comparatively small. Colonel Trench adds that, so far as the carriage bodies were concerned, it is probable that neither would have been so damaged as to involve serious risk to persons therein, had it not been for the collapse of the six-wheeled van, which came between them, and the telescoping of that vehicle into the leading portion of the body of the third coach. The report concludes by observing that the action of the shock-absorbing buffers must have been of material value in reducing the effects of the collision. Naturally, we are led to pass from this question to the companion one of all-steel coaches. There was a very interesting discussion on that subject at the Madrid Railway Congress, when, it should be noted, the main point lay in the suggested conclusion that "Considerations of safety are, in themselves, sufficient to justify the use of metal construction for coaches." The delegates from British railways could not subscribe to that, and eventually the wording was considerably modified. Moreover, as Mr. Gresley pointed out, the requirements of the traveller on British railways call for coaches with compartments and corridors; those countries which had widely adopted all-steel carriages used the open type of coach and the results had, it was admitted, been justified. The present collision at Culgaith appears to us to suggest that there are other remedies against telescoping and against subsequent fire in the wreckage.

The World Power Conference at Berlin.

No. III.*

WE continue below our account of the formal technical meetings of the Conference, again dealing only with those sections which we regard as being of particular interest to our readers.

THE CONSTRUCTION AND OPERATION OF LARGE POWER PLANTS.

A very large audience assembled to discuss this subject, under the chairmanship of Mr. I. E. Moultrop, the chief engineer of the Edison Electric Illuminating Company, of Boston, well known for his pioneer work with 1400 lb. steam pressure at the Edgar Station. The reporter of the section was Dr. Ing. M. Rehmer, director of the Berlin Electricity Company. The morning being intensely hot, the Chairman gained the sympathies of the meeting at the outset by inviting all suffering from the heat to sit in their shirt-sleeves, and maintained it by his good-humoured firmness in suppressing speakers at the expiry of the time that could be allowed them. By this means it was possible to hear the views of some nineteen different speakers, in addition to the reading of the report by Dr. Rehmer. Nine papers were summarised in the report, three of which were by British authors. These included an account of modern practice with regard to purifying flue gases, with special reference to the important work carried out by the London Power Company as a sequel to the Battersea controversy. This paper was contributed by Dr. S. L. Pearce. Dr. Lessing presented one arguing for the feasibility of greatly reducing the ash and sulphur contents of coal by washing, and the economy gained thereby. Mr. Stephen Lacey proposed international co-operation in dealing with the problem of laying and maintaining the cables and pipes necessary to serve a large city. The planning of power systems was discussed by Mr. E. C. Stone from the American point of view, while Dr. W. E. Wellmann dealt with the planning of power stations from the German aspect. Apart from flue gas treatment, the most important subject brought before the section was the question of coping with a sudden emergency load in power stations. Dr. A. Peucker put forward the view that if turbines were properly designed—*i.e.*, attention paid to the number and disposition of the valves to be manipulated and to the diminution of danger from temperature stresses—they could be started up quickly enough to enable an instantaneous reserve of power largely unnecessary. Mr. Eric Brown, of Brown, Boveri and Co., advocated the principle of keeping the turbines which might be suddenly required ready warmed up. Warming them by steam was objectionable from many points of view, the proper method in Mr. Brown's opinion being to maintain their temperature by means of a flow of hot air. The absence of condensation in such a case reduced the consumption of heat to about 1 kW per square metre of external surface, and would enable a 30,000-kW turbine to be kept hot for an expenditure of heat equivalent to only 280 kilos. of steam per hour, as compared with a no-load consumption of 9000 kilos. As might be expected, the question of enabling a power station to deal with sudden loads drew remarks from both the advocates of Diesel engines and of steam storage. Indeed, the meeting began to grow somewhat tired of the latter. There was also evidence of considerable difference of opinion as to what was really required or possible in the way of rapid starting. Dr. Föhl pointed out that in the case of the sudden failures of an incoming transmission line, power would have to be supplied in three to five seconds if the frequency and voltage were to be maintained, so that the starting time of three minutes claimed for some systems was not good enough. The only practicable way of ensuring oneself against the result of such failures was to have sufficient excess capacity of machinery running to take up the load automatically. Herr Max Gercke made the best case for Diesels, as against steam turbines, for emergency work. He took twenty-five minutes as the minimum starting time for a 20,000-kW steam turbine, forty-five minutes for one of the machines of 30,000 kW and upwards. In the case of a 16,000-kW unit there were fifty valves of one sort or another, thirty of them had to be opened by the driver when starting and twelve closed afterwards. A pair of 7500-kW Diesels, on the other hand, required only seventeen valves and four switches, and only three valves had to be closed after starting. In consequence, a Diesel engine of this size could be started in from two to three minutes if the staff—one man at the engine and one on the switchboard—were previously warned. Even if the start had to be made when everybody was unprepared, it would take only four or five minutes at the most. On the occasion of the inspection by many members of the Conference of the pair of 7500 Diesel-M.A.N. engines in the Hennigsdorf station, the time of starting claimed by Mr. Gercke was easily confirmed. Among the speakers at the meeting, Dr. Münzinger alone referred to the aspect of quick starting of steam plant from the boiler-house point of view. Until we could make electricity direct from coal the boiler would always be essential to large thermal power stations. Extraordinary development was taking place with regard to pressures and to sizes of units, but there were other problems to be overcome. An extremely promising recent development was the use of powdered fuel in conjunction with mechanical stoking. An ordinary travelling grate burned coal at the rate of 300 kilos. per square metre per hour, and the peak after that was taken by pulverised fuel in the same furnace. Such an arrangement gave a very large range of economical output and allowed the ashes and slag from the pulverised coal to be simply disposed of. No economiser was needed, and with preheated air available for starting a boiler could be got away from cold in twenty minutes. With regard to questions of smoke and flue gas treatment, British speakers were to the fore. Dr. Pearce gave the new information that, in the Battersea flue gas washing plant, the contact time of the gases with the water and the wetted surfaces lasted from 23 sec. to 44 sec. The metallic contact surfaces provided amounted to 8000 square feet for every ton of coal burnt per hour. The cost of treating the flue gases would not exceed 15d. per ton of coal burnt, a figure

* No. II. appeared June 27th.

which had to be compared with that of the transport of coal or electricity had the station been situated elsewhere. Dr. Pearce's succinctness and brevity were certainly appreciated, and might with advantage have been emulated by other speakers. Dr. Lessing believed that the power station of the future would be designed for the use of coal almost entirely freed from sulphur and ash. Mr. S. B. Donkin held that the purity of flue gases ought to be submitted to criticism before they left the chimney and not after, and advocated a standard of purity based on the solid matter contained in a given volume, with standard CO_2 content. Mr. B. Pochobradsky described a combination of cyclone and filter which would remove 99 per cent. of solid matter from flue gases, and Herr Buff claimed that electro-deposition of dust had succeeded where washing methods of cleaning had failed. The need for international action to bring about fairness in competitive tendering and in guarantees was emphasised by Doctor-Professor E. A. Kraft, the chief of the turbine department of the Allgemeine Elektricitäts Gesellschaft.

Proposed European Super-power Lines.

In a general address given by Dr. Oskar Oliven, the proposal was put forward for a European super-power network which, operating at 380,000 to 400,000 volts, with three-phase current transmission, would link up the principal countries by a line having a total length of 10,000 kiloms., or over 6200 miles. It was proposed to construct high-pressure transmission lines from Scandinavia to Italy and the Alps, from Calais to Lisbon, Warsaw to the Balkans, other possible lines being from Poland to Paris and Rostow—on the Don in South Russia—through Austria and Switzerland to Lyons in France. Such a network, it is claimed, would make possible the better use of existing power plants and would open up hitherto undeveloped sources of power which would supply current to new and extensive districts. The author recognised the difficulties with which such a scheme would be surrounded, but he did not look on them as insurmountable. He regarded the time as now ripe to consider this question from the point of view of European power economics, so that the extensions which were from time to time made to the existing power networks would be such as to tend towards an organic whole with the most beneficial results to each and all of the European countries.

The Construction of Large Generators and Other Electrical Machines.

No less than seventeen separate papers were dealt with in the report under the above heading presented by Professor Dr. Kloss. The meeting at which the report was discussed was presided over by Dr.-Ing. Fleischmann. The maximum sizes in which steam turbo-generators had been, or were now being, built were 72,000 kW for a two-pole machine at 3000 revolutions, 160,000 kW for a two-pole machine at 1500 revolutions, 94,000 kW for a four-pole machine at 1800 revolutions, and 100,000 kW for a four-pole machine at 1500 revolutions. A 16,000 kW unit could be built for about 18·5 kilos. per kW and one of 80,000 kW for about 13 kilos. per kW. The weights of generators alone of the two-pole type, with the now universal welded housings, were about 2·16 kilos. per kVA, while for large four-pole machines, the corresponding figure was about 2·25 kilos. per kVA. Rotor diameters were limited by the permissible stresses. Siemens-Martin steel was used for rotors up to 700 mm. diameter, while for larger diameters heat-treated chromium-nickel steel was used, with a yield point of 4500 to 5000 kg./cm.², a tensile strength of 6500 to 7000 kg./cm.², an elongation of 15 to 20 per cent., and a notch impact strength of 7 kilogramme-metres. Chrome-nickel steel had to be hardened after forging and again annealed and quenched-tempered. Great care had to be taken with the heat-treatment, as several cases of bursting of rotors due to heat-treatment stresses, had been experienced. The rotors were bored with an axial hole of 100 mm. diameter to facilitate heat-treatment, and the metal of the bore carefully examined with a periscope. The soundness of the metal in the case of the A.E.G. Company's rotors was further tested by the electro-magnetic method due to Dr. Pohl. Extraordinarily high efficiencies could be obtained with modern generators, the figures ranging from 97 to 98 per cent. For water-wheel driven generators, the modern limits of size were estimated very variously by different authors, opinions varying between 7000 kVA, 30,000 kVA at 1000 revolutions, between 33,000 kVA and 60,000 kVA at 500 revolutions and between 60,000 kVA and 100,000 kVA at 300 revolutions. Among the largest machines so far actually constructed were generators of 35,000 kVA at 375 revolutions; 40,000 kVA at 300 and at 138 revolutions; 65,000 kVA at 107 revolutions and 77,500 kVA at 88·2 revolutions. Asynchronous machines were now constructed, as purely reactive machines, for capacities up to 40,000 kVA. They required, of course, special methods of starting, all devised with the idea of increasing the voltage of the stationary rotor so that the current in it might not exceed the commutating capacity of the exciter. Squirrel-cage induction motors were becoming increasingly popular, especially since it had become possible by means of double-slot armatures to obtain a starting characteristic even superior to that of a synchronous machine. Motors of several hundred horse-power could thus be directly connected to the mains, and that was customary in America, though, generally, prohibited by the regulations in force in European countries. As regards mercury rectifiers rapid progress had been made since the introduction of the ironclad rectifier in 1911, and capacities had been increased to 10,000 ampères. The trouble due to "backfiring" was considered to have been overcome by the introduction of an anode protective grid, which had allowed of a great increase in the capacity of rectifiers. The reliability of the mercury rectifier had been demonstrated by the freedom from trouble on the Berlin electric railways for which mercury rectifiers were used exclusively. A special type of rectifier had been developed by Mr. Mitsuda, of Tokio. This apparatus, called by the inventor a "mercury inverter," converted direct into alternating current by controlling the arc by means of a rotating perforated disc. Another type of "inverter" would change the voltage of a direct current, or might be used as a frequency changer for alternating current. During the discussion, which turned largely on questions of design, Professor Punga warned engineers against exceeding the practical limits of two-pole machines. Two-pole generators of a capacity of 90,000 kVA at 3000 revolutions were even now being talked of. The difficulties were by no means confined to mechanical stresses, as the problem of vibration was always serious and there was also the danger of damage to insulation by the moving of the windings in the slots. It might be better to employ four-pole designs, or, when high speeds were necessary, to duplicate the generators. Professor Franz Unger spoke with high praise of a new method of insulating aluminium transformer windings, by means of a semi-liquid composition containing kaolin, which was burnt on them. The adherence to the aluminium was excellent, and the windings could safely be worked at very high temperatures. With regard to large transformers, another speaker mentioned that negotiations were now taking place for the supply of an extra high-tension transformer weighing as much as 127,000 kilos. without its tank, the latter containing 44 tons of oil. The shipping weight of the transformer would be 151,000 kilos. Transport would be effected by two bogie trucks of nine axles each. The efficiency of the transformer would be 99·11 per cent.

Steam and Electrically Operated Railways.

The seventeen papers submitted under this heading were summarised by two reporters, both directors of the German railway system, Dr. Fuchs submitting a report on the papers dealing with steam-operated railways and Dr. W. Wechmann on those concerned with electrified lines. Monsieur Châtel, engineer to the Nord Railway in France, held the view that the ordinary Stephenson type of locomotive boiler reached its limit at a pressure of 35 atmospheres. Calculations indicated the advisability of operating locomotives with a pressure of 60 to 80 atmospheres and a steam temperature of 400 deg. Cent. He hoped that a locomotive working at 60 atmospheres would be built, so that some results of actual operation under such conditions might be available. Dr. Fuchs, in collaboration with others, described and discussed recent advances in practice on the German railways. Heavy locomotives were now designed with an axle load of 20 tons, boiler pressures had been increased from 12 to 16 atmospheres, and superheating from 300 deg. to 400 deg. This last temperature was only advantageous in compound locomotives when running at full load, and even then the gain was only about 4 per cent. For this reason simple expansion engines were preferred. Two designs of pulverised fuel locomotives were now in use on the German railways, one that of the A.E.G. and the other that of the Locomotive Research Association. The difference between them was little more than that of the shape and position of the burners, and of the feeding and auxiliary apparatus. In both designs both primary and secondary air were supplied. The results of tests was to show that the pulverised coal system was better than ordinary firing, especially where high outputs were concerned. At low powers the power consumed by the auxiliary apparatus was a drawback. Boiler efficiencies had been improved and in certain instances locomotives could be run with only 35 per cent. excess air, and 14 per cent. of CO_2 in the exhaust gases. Whereas only three papers dealt with steam locomotives, no less than thirteen were devoted to matters connected with electrical or other methods of operation. The only British authors were Messrs. C. H. Merz and F. Lydall, who discussed general questions of organisation and the maintenance and repair of equipment from their own experience, and gave particulars of the organisation on ten different railway systems. During the meeting, the progress made with pulverised fuel locomotives in Germany was described by more than one speaker. There were now four heavy goods engines of this type in service, and the difficulties connected with refractories seemed to have been overcome. The view was expressed that the usual comparisons between the performances of high-pressure and ordinary locomotives were unfair, as the old type had a century of development behind them, whereas high-pressure engines were in their infancy. Professor Lomonossof took up the cudgels for the Diesel locomotive. He told the Conference that Diesel locomotives must either be shown unsuitable for railway traction or included in the discussion. They could not be ignored. Moreover, as designers in different countries tended to make exactly the same mistakes, an international discussion of such engines was likely to be very valuable. Herr Dittman thought that, on account of the good results obtained by a Diesel electric locomotive put to work in the Argentine some six months ago, the Diesel electric system was likely to be adopted for the lines around Buenos Ayres. At all events, it was likely to be a very long time before any general electrification of the Argentine railways would be feasible. The question of the best system of electrification for railways generally was brought no nearer solution by anything that was said in the discussion, and it is unlikely that it will ever be settled by argument. Three-phase, single-phase, and direct-current working all have their advocates, each of whom can point to important and successful work accomplished. Sixty per cent. of the Swiss railways were said by Herr Eggenberger to be already electrified, and 85 per cent. of the traffic was carried on this portion. The Swiss system depended on single-phase current carried by 66-kV transmission lines; the eastern and western areas being interconnected by 130-kV lines. Señor Solar referred to the 3000-volt direct-current system in Chile, where automatic sub-stations were in use before they were employed in Europe. There were 1500 kiloms. of electrified track between Santiago and Valparaiso, using 30 million kWh of power yearly. The future of railway electrification was assured in Señor Solar's opinion by the development of the mercury rectifier. The three-phase system of electrification was represented by Signor Oreste, who contributed information concerning the Italian railways, and a new system altogether, embodying the superposition of a low-frequency power current on a three-phase high-frequency line, was referred to by Dr. Jakob. The same line could thus carry low-frequency current for railway working and normal-frequency current for lighting and industrial purposes, at the same time. Another speaker put forward a suggestion only remotely concerned with railways, namely, the use of electric energy for the electrolysis of water, the resulting oxygen being sold, and the hydrogen used as fuel for internal combustion engines. A special hydrogen engine had already been designed. If the idea proves commercially practicable it may afford a means of improving the load factor of power stations. The only British speaker in the discussion was Mr. Theodore Rich, who wondered whether railway engineers, considering electrification, were not sometimes deterred by the fear of placing themselves in the hands of the great electrical monopolies being formed by the process of "rationalising" industry.

Internal Combustion Engines.

Although this subject was partly touched upon in the two sections relating respectively to power supply on ships and the mechanical transmission of power, both of which were referred to in our last issue, it was mainly dealt with in two further sections. The first of these embraced the more specialised forms of engines used for aircraft and automobile work, while the other section, the stationary internal combustion engine was dealt with, together with the research work done in this connection.

The general reporters for the aircraft and automobile section were Min. Dir. Dr. Brandenburg and Dr. Heller, and the chair was taken by Professor Ing. Guiseppe Belluzzo. There was, it was mentioned, so much reserve with regard to publishing information on aero engines, that only two papers were received, both from Italian engineers, which, however, came too late to be included in the report. In his summary Dr. Brandenburg touched upon the principal problems connected with aircraft engine design, the most important of which, he said, were the reduction of unit weight, greater reliability and reduced fuel consumption. Although the original unit weight was 4 kilos. per horse-power, weights of 1·0 kilos. to 0·6 kilos. per horse-power were now quite usual. Reliability in operation had been increased by not cutting down the weights too much. Fuel consumptions were being reduced by increasing the compression ratio, and the two papers by Enoch and Herzfeld, although dealing mainly with automobile engines, bore upon that subject. With regard to cooling, the air-cooled engine had been greatly developed, but progress had also been made in the design of water-cooled engines, in which liquids having a high boiling point are advantageously employed. The Diesel airless injection system offered distinct possibilities of further development. In the papers on the Diesel engine as used for transport purposes, some interesting figures were given as to the use of such engines, both in Germany and abroad. In his paper, Dip.-Ing. F. Schultz stated that there were now 245 motor lorries fitted with heavy-oil engines of the Acro-Bosch, Daimler, Benz, Deutz, Junkers and M.A.N. types on the road in Germany and 230 such vehicles abroad, while in October, 1929, there were no less than 1882 Diesel locomotives, including 134 mine locomotives, in service.

The heavy-oil engine drives, he stated, effected savings of from 70 to 80 per cent. in the cost of fuel compared with petrol engines, and about 15 per cent. as against steam when used aboard ships. Even

for aircraft work the heavy-oil engine was, he suggested, a promising competitor with the petrol engine, for the Junkers and Dornier-Packard engines had only a weight of 1·4 kilos. per horse-power, which was not much greater than that of existing aero engines. Some other papers dealt with the use of oil engine driven vehicles in the Argentine and also experience with power gas produced with solid fuels in Finland. The progress of the automobile engine in France and in Czechoslovakia was also dealt with. In summarising this section, Dr. Heller called attention to the necessity of providing a suitable supply of fuel for the increasing number of motor vehicles. These fuels must include, he suggested, not only mineral oils and vegetable oils, but also alcohol, lignite and wood. An important task was that of collecting and distributing further knowledge with regard to the economic aspects of motor traffic so that in countries about to extend their transportation facilities, advantage might be taken of the experience already gained.

Several of the speakers, including Dir. C. A. Fieber, of Graz, Austria, and Professor E. Hubendick, of Stockholm, referred to the Hesselman low-pressure heavy-oil motor, of which several examples had been built and tested. In this engine, which works at a compression pressure of 7 to 9 atmospheres and a maximum compression of 24 to 26 atmospheres, direct injection was employed, each cylinder being provided with its own fuel pump driven from the crank shaft. The entering air was given a rotary motion by means of a shielded inlet valve and ignition was effected by a high-tension electric plug, over which the fuel-air mixture was deflected. These engines had given excellent results on the test bench and in motor lorries, when using intermediate or gas oils, and savings of the order of 30 per cent. in the volume of fuel necessary and 73 per cent. in fuel cost, taking the comparative values of petrol and gas oil in Austria, had been shown.

The low-pressure engine offered, it was suggested, a promising solution of the problem of the small power heavy-oil motor for transport work, and was capable of using fuels similar to those employed in the high-pressure Diesel engine. Other speakers referred to the use of hydrogen generated from the high-pressure method of water electrolysis by employing cheap current during the high load periods.

STATIONARY OIL ENGINES.

In the section relating to internal combustion engines of the stationary type, Professor Dr.-Ing. Nägel presented a summary of eleven papers. Professor Ing. P. Ostertag, of Switzerland, was the chairman of the meeting. The papers covered wide fields and included contributions on the development of oil engines in seven different countries, namely, Great Britain, America, Germany, Czechoslovakia, Switzerland, Austria and Russia. The British papers were those of Mr. Alan E. L. Chorlton and Mr. Bird, of Cambridge, which covered the work recently done in Great Britain on heavy-oil engine research. The excellent co-operation between research institutes and industrial laboratories was commented upon, and the work on combustion which has been done by Bone, Newell and Townend noted. In the paper by Mr. A. L. Bird, of Cambridge, the characteristics of nozzles and sprays for oil engines were very thoroughly dealt with and described. A noteworthy feature of the American paper by J. Kuttner was the emphasis laid upon the importance of mass production, which influenced the design of engines. In America there were fewer types and construction was simple with corresponding lower sale costs. It was interesting to hear that American industry only spends 3·3 per cent. of its output for fuel and power, and that more than 50 per cent. of the engines built in that country operate on the two-stroke system, many with crank case scavenging. The "Price" system of airless injection was very largely employed. In the German paper by M. Gercke and Dr. A. Bannwarth, attention was drawn to the use of oil engines for peak load supply, and figures given for the Hamburg, Bremen and Hennigsdorf plants. The Swiss contributions of Professor Osterlag and Dip.-Ing. A. Büchi dealt with progress made by Sulzer Bros., and the system of exhaust-turbo-charging invented by Mr. Büchi, who, during the course of the discussion which followed, gave some interesting figures relating to the very easy starting of turbo-charged engines. In Czechoslovakia progress was reported in the construction of large horizontal oil engines embodying gas engine practice, while D. F. Merkl, of Austria, described in some detail an interesting new engine of the Scott-Still type. In the Merkl engine, however, steam is produced in the working cylinder by injecting water heated in the jackets and by the exhaust gases, which evaporates and produces power on the uniflow steam principle. No performance figures or efficiencies were, however, given for this new engine.

In the course of an interesting discussion, Dr.-Ing. F. Schulz drew attention to the possible use of industrial power stations for peak load purposes, by connecting private power plants to the local distribution system. He claimed that considerable savings on capital could be effected by these means and the works power plants operated more economically. We understand that this system has been successfully employed in Belgium for some years. Ing. H. Becker, of Augsburg, spoke in favour of the high-speed vertical engine as compared with the horizontal type of engine, and mentioned the better balancing of the multiple cylinder vertical engines and their excellent fuel consumption. As previously mentioned, Ing. Büchi gave figures showing the very quick starting of the four-stroke exhaust turbo-charged oil engines, and showed that it was due to the absence of cylinder cooling which was often noticeable when starting on air in the ordinary manner. It was suggested by Dr. Merkl that, for gas engines, a poor gas might quite well be enriched by adding oxygen which might be electrolytically produced. Another speaker also referred to the production of hydrogen by similar means, utilising cheap current. Professor G. Lomonossoff outlined the desirable conditions for the design of an oil engine suited for locomotive driving, and Dr. Geiger, of Augsburg, gave further particulars of the performance of the Diesel compressed air locomotive designed and built for the German State Railways, which was fully described in our issue of May 2nd last. Dr. Geiger pointed out that, whereas in the case of the Diesel electric locomotive, it was only necessary to join together well-known component parts in the compressed air system, new methods were adopted, such as water injection in the air compressor, which had given reliable and satisfactory operation on service. The progress made with the coal dust motor was referred to by R. Pawlikowski, who mentioned a new type of engine now under construction.

In summarising the discussion, Professor Dr. Nägel spoke on new research work which had recently been done on spraying nozzles and combustion, and suggested that additional research work on atomisation and the continuous flow of fluids through nozzles was required. Lord Rayleigh had determined the laws under which a stream of fuel was broken up into drops, and Constantin and Weber had shown the effect of velocity. More recent work had taken into account the value of viscosity and surface tension, and the results showed that many phenomena, which were thought to be combustion problems, were simply matters of atomisation. That was especially marked when changing over from one fuel to another. Work was being done in several countries and would, he thought, lead to valuable practical results.

(To be continued.)

BOOKS RECEIVED.

The Advertisers' A B C, 1930. London: T. B. Browne, Ltd., 163, Queen Victoria-street, E.C. 4 Price 21s net.

Journal of the Institution of Engineers (India). May, 1930. Calcutta: The Institution of Engineers (India), 8, Esplanade-row.

Seeing by Wireless (Television). By Ralph Stranger. London: George Newnes, Ltd., Southampton-street, W.C. 2. Price 1s. net.

Canal Irrigation in the Punjab. By Paul W. Paustian, Ph.D. London: P. S. King and Son, Ltd., Orchard House, S.W. 1. Price 12s. net.

Gmelins Handbuch der anorganischen Chemie. 8 Auflage. System-Nummer 59. Eisen. Berlin: Verlag Chemie G.m.b.H., W. 10. Price 24 marks.

Report of the Food Investigation Board for the Year 1929. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

The Measurement of Hydrogen Ion Concentration. By Julius Grant. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 9s. net.

The Mechanism of Nature. By Professor E. N. Da C. Andrade, D.Sc., &c. London: G. Bell and Sons, York House, Portugal-street, W.C. 2. Price 6s. net.

Trade Mark Law and Practice. By A. W. Griffiths, B.Sc. (Eng.). London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

Autobiographical and Other Writings. By A. A. Campbell Swinton, F.R.S., &c. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 10s. 6d. net.

Economic Conditions in the Netherlands, 1919. Report by R. V. Laming. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 3s. net.

Facts and Figures of the Automobile Industry, 1930. New York City: National Automobile Chamber of Commerce, 366, Madison-avenue, at 46th-street, N.Y., U.S.A.

Economic Conditions in Sweden. Report by W. J. Glenny, O.B.E. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. 6d. net.

The Development of the Federal Program of Flood Control on the Mississippi River. By A. De Witt, Ph.D. London: P. S. King and Son, Ltd., Orchard House, S.W. 1. Price 17s. net.

A Condensed Outline of Modern Physical Chemistry. By F. H. Constable, M.A., D.Sc., &c. London: Ernest Benn, Ltd., Bouverie House, 154, Fleet-street, E.C. 4. Price 10s. 6d. net.

A Critical Review of Literature on Amplifiers for Radio Reception. Radio Research, Special Report No. 9. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 5s. net.

Between Two Oceans: Rapid Chilling and Freezing Systems for Fish and Meat. By M. T. Zarotschenzeff. London: *The Cold Storage and Produce Review*, Empire House, St. Martin's-le-Grand, E.C. 1. Price 5s. net.

Fuel Research Technical Paper No. 25: The Reactivity of Coke: 3. The Influence of Iron Compounds. By J. H. Jones, J. G. King, and F. S. Sinnatt. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 9d. net.

A New High-Tension Testing Laboratory.

ON June 14th, a new testing department was officially opened at the porcelain insulator works of Ph. Rosenthal & Co., A.G., at Selb, Bavaria, for investigations on insulation for very high voltages. In view of the fact that 220,000-volt lines are already in operation, and that at a later date they may be worked at pressures of 380,000 volts, and that it is considered that even higher pressures will be needed in the future, the equipment in the new department has been designed for testing at pressures up to 2 million volts. That has been necessary in order to deal with all insulation problems that may arise, and the adoption of this exceptionally high testing pressure is in no sense an attempt to establish a record. The construction of the laboratory is the result of long experience, and every effort has been made to ensure that tests are made under conditions corresponding to those of actual practice. A reinforced concrete building has been provided with a flat roof to enable experiments to be carried out in the open. Moreover, in view of the fact that many experiments have to be made in the dark in order to trace the faintest luminous phenomena, the building has been constructed without windows. In order to avoid the jumping of arcs from the testing apparatus to the walls, the building has large dimensions, *i.e.*,

FIG. 1—1,000,000-VOLT TRANSFORMER

30 m. by 22 m. by 21 m., or 98ft. by 72ft. by 69ft. There are two independent testing equipments—the alternating current equipment, working at standard frequency, and the impulse equipment. In the old testing shop there is also a high-frequency equipment designed for a pressure of 2 million volts to earth.

Two transformers, each designed for 1 million volts to earth, have been provided, and the first of these transformers is now in use. Apart from a similar, though somewhat smaller, transformer erected in the testing department of the A.E.G., this transformer, which is shown in Fig. 1, is claimed to be the only unit with a single container capable of producing a million volts. The advantages claimed for the transformer are the small space it requires, accessibility of all parts and simple regulation. The total height is 8 m., or 26ft. The tension is measured by means of a sphere spark gap—see Fig. 2—the copper balls of which have a diameter of 2400 mm., whilst the largest spheres used in the past are said not to exceed 1000 mm. in diameter. Each of the spheres weighs about 700 kilos., or 1543 lb.

The room containing the electrical machines and the cells for the switching equipment is separate from the experimental department, and the machine foundations are insulated from the remainder of the building by an air gap 10 mm. wide in order to prevent the transmission of mechanical vibrations and shocks.

The continuous current impulse plant—see Fig. 3—represents the latest practice. It is designed to occupy a very small amount of floor space and is, of course, intended to produce voltages resembling those caused by lightning striking the line, the desired effect being obtained by charging condensers. The whole of the switching operations are carried out

from a desk on a gallery, so that the engineer carrying out the tests does not have to walk from one switch to another and the whole of the testing department may easily be surveyed. In order to avoid accidents all doors are provided with contacts which open switches when the doors are opened, thus making the apparatus dead.

After the testing department had been described

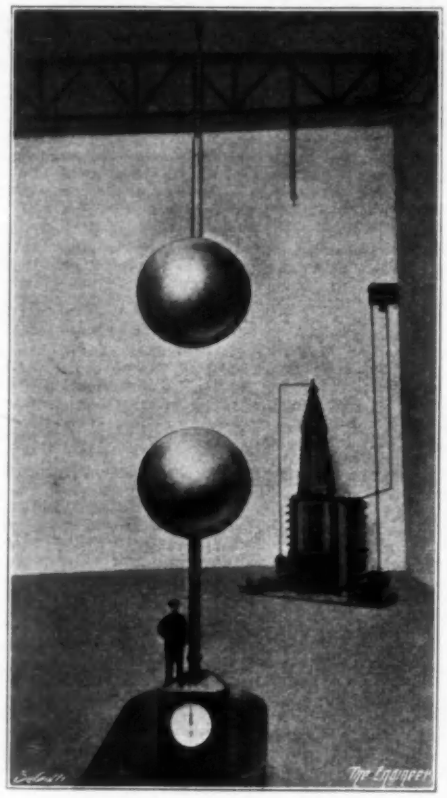


FIG. 2—SPHERE SPARK GAP

on the occasion of its official opening, various experiments were carried out. An insulator chain composed of fourteen large insulators was made to flash over at a tension of about 1 million volts, the length of the arc being about 4 m., or, say, 13ft. Corona phenomena were demonstrated on wires, showing how, after a

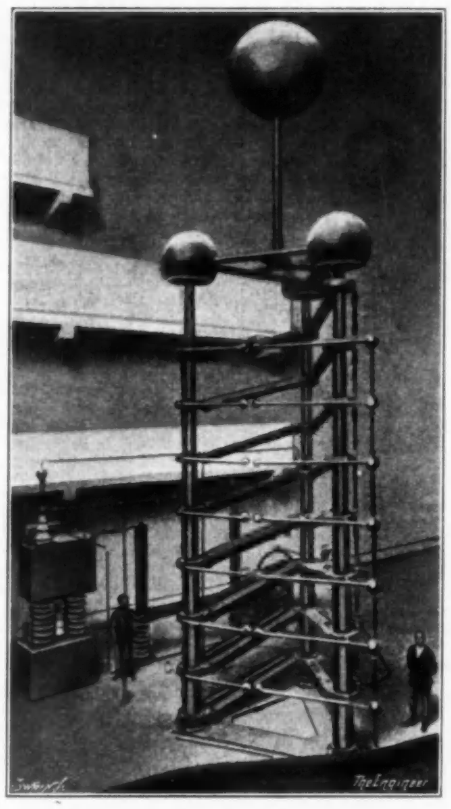


FIG. 3—CONTINUOUS-CURRENT IMPULSE PLANT

critical tension, the wire is covered by a luminous layer. Impulse flash-over phenomena were also demonstrated on an insulator chain at a tension of more than 2 million volts, the discharge being accompanied by a great noise.

The Iron and Steel Industry on the Continent.

IN order that the Committee of the Economic Advisory Council might have first-hand information with regard to the industrial conditions in the iron and steel industry in France, Belgium, Luxemburg, Germany and Czechoslovakia, a delegation visited those countries. The information obtained as the result of the visit has just been published as a White Paper—Cmd. 3601.

The members of the delegation were Mr. John A. Gregorson, General Secretary of the British Iron and Steel Trades Employers' Association, on behalf of the National Federation of Iron and Steel Manufacturers; Mr. R. Dennison, Assistant General Secretary of the principal Workers' Organisation in the British Iron and Steel Industry—the Iron and Steel Trades Confederation; Mr. E. C. Ramsbottom, Director of Statistics, Ministry of Labour, and Mr. F. S. Flint, Overseas Section, Statistics Division, Ministry of Labour.

The delegation left London on January 20th, and returned to London on February 14th, 1930, having, in the meantime, interviewed Government officials, employers' organisations and trade unions and visited a considerable number of the principal iron and steel works in the five countries.

The summary of the Report which follows has been prepared by the National Federation of Iron and Steel Manufacturers.

The Report first deals with statistics of production and exports in France, Belgium, Luxemburg, Germany and Czechoslovakia, which show that the iron and steel industries in those countries are developing at a greater rate than in Great Britain. The Report then deals in more detail with specifically labour questions.

Discussing unemployment, the Report states that in France, Belgium and Luxemburg no unemployment was found; in Czechoslovakia there was little unemployment, while in Germany the percentage wholly unemployed in the metal industries, including engineering, was 14·1 per cent., with 16·1 per cent. on short time. In France it had been necessary to import about 200,000 foreign workers for the iron and steel works and the iron ore mines. In Luxemburg 40 per cent. of the workers were foreigners, but in Belgium only a minority of the workers were foreigners; in Germany and Czechoslovakia there was practically no foreign labour.

Dealing with the organisation of the workers, the Report states that in none of the countries visited, except Germany, is there any effective organisation of the workers in the iron and steel industry comparable with that of Great Britain. In France such organisation as exists has only a minor influence; in Belgium about 60 per cent. of the workers are organised in trades unions, but the unions do not make collective agreements with employer, and wage contracts are made between the employer and worker. In Luxemburg about 60 per cent. of the native workers are organised, the unorganised native workers being principally the unskilled. In Germany the organisation and functions of the trade unions are similar to those of Great Britain.

The following table shows the rates of pay for skilled, semi-skilled and unskilled workers, and the average for all workers for a normal working week in the countries visited :—

Average Weekly Wages.

	Skilled.	Semi-skilled.	Unskilled.	Average of all workers.
	s. d.	s. d.	s. d.	s. d.
France ..	51 6	40 3	32 2	37 0
Belgium ..	53 9	38 10	30 10	35 5
Luxemburg ..	49 2	38 10	32 0	36 7
Germany ..	68 6	52 10	47 0	50 11
Czecho-slovakia ..	58 5	32 11	23 2	30 5

The following table summarises the average weekly hours at blast-furnaces, rolling mills, &c., in the countries visited :—

Average Weekly Hours.

	Blast furnaces.	Melting Shops.	Rolling mills.
France	56	50	48
Belgium	56	52	48
Luxemburg	56	50	48¾
Germany	56	53	48
Czechoslovakia	56	48	48

Overtime rates vary in the different countries. In France some works pay only ordinary rates, at others the overtime extra varies from 25 to 50 per cent. on weekdays to 100 per cent. on Sundays. In Belgium overtime is by law paid at 25 per cent. above the ordinary rate for the first two hours and 50 per cent. thereafter, with 100 per cent. on Sundays. In Luxemburg the overtime rate is generally 30 per cent. above the ordinary rate on weekdays and 60 per cent. on Sundays. In Germany the prevailing overtime extras are time and a quarter during the ordinary normal week and time and a half for work on Sundays. In Czechoslovakia various overtime rates are paid averaging about 38 per cent. above the usual rates.*

Having regard to the importance of the Report, it is felt desirable to give the summaries of observations by the delegation in respect of each of the five countries visited.

France.—The iron and steel industry of France has considerably increased its capacity and become equipped with the most modern plant. The equipment and modernisation of the plant have been carried out mainly by reparations and assisted by the depreciation of the franc. In addition, the valuable ore fields of Alsace-Lorraine are now at the disposal of the industry. The post-war development of the industry has been so great that a serious shortage of labour had to be faced. This has been dealt with by a co-ordinated system of importing foreign labour, and such importation still continues.

The non-existence of effective organisation of the workers, or of collective agreements, leaves the employer free to make individual contracts of service and wages with each workman. No such disparity as in Great Britain exists between the wages and earnings of skilled, semi-skilled and unskilled workers. There is little disparity between the earnings of corresponding grades of workers in each of the departments—blast-furnaces, steel melting shops and rolling mills. The reason given was to ensure mobility of labour from one department to another throughout the whole works.

The concentration of the works in agricultural areas leaves the employer considerable latitude in the fixation of wage rates and social allowances.

While State regulation of hours of work exists, the system under which such State regulation is applied by means of administrative decree, to the separate industries, gives the employer considerable freedom and latitude in the matter of effective working hours. The provisions for extensions of hours beyond the normal effective hours fixed by the decree enables the employer, on an average throughout the year, to exceed the 48-hour week.

No provision, either by State law or collective agreement, exists with regard to overtime extra, except to a limited extent in respect of the additional hours mentioned above. In this case, however, overtime rates are payable only when customary.

State schemes of social services have not been developed to the same extent as in Great Britain.

The modernisation and equipment of the works have resulted in a minimum of manning of the various units of plant.

The reporters remark that the physique and general appearance of the workers were good and they were hard at work. An atmosphere of keenness and good relationship among managements and workers seemed to exist. As the result of the war, France has established a great iron and steel industry, is determined to maintain it, and there is marked evidence of intention still further to improve the plants and equipment, and to increase the volume of output.

Belgium.—The iron and steel industry of Belgium has considerably increased its capacity and become equipped with the most modern plant. The equipment and modernisation of the plant has been carried out mainly by reparations, State aid and new capital issues.

While there exists in Belgium a representative trade union, no system of collective bargaining or collective agreement exists, the employer being free to make individual contracts of service and wages with each workman.

No such disparity as in Great Britain exists between the wages and earnings of skilled, semi-skilled and unskilled workers. There is little disparity between the earnings of corresponding grades of workers in each of the departments—blast-furnaces, steel melting shops and rolling mills. The reason given was to ensure mobility of labour from one department to another throughout the whole works.

State schemes of social services have not been developed to the same extent as in Great Britain. Social allowances, however, exist in the form of company's houses at nominal rents, cheap food supply, stores and clothing.

The delegation found that at one large works visited the modernisation and equipment of the works had resulted in a minimum of manning of the various units of plant.

The physique and general appearance of the workers were good and they were hard at work. It was evident that Belgium has re-established its iron and steel industry on a much larger scale than in pre-war days, is determined to maintain it, and still further to increase plant equipment and the volume of output.

Luxemburg.—The iron and steel industry of Luxemburg has, since the termination of the war, increased its capacity and still further modernised and improved its equipment. The Germans kept the iron and steel works in a state of efficiency and used them to their utmost capacity.

The development of the iron and steel industry has necessitated the importation of at least 40 per cent. of foreign labour.

The non-existence of collective agreements, despite the workers' organisation, leaves the employer free to make individual contracts of service and wages with each workman.

No such disparity as in Great Britain exists between the wages and earnings of skilled, semi-skilled and unskilled workers. There is little disparity between the earnings of corresponding grades of workers in each of the departments—blast-furnaces, steel melting shops and rolling mills. The same reason was given as in the case of Belgium.

The situation of the Luxemburg works, mainly in agricultural areas, leaves the employer considerable latitude in the fixation of wage rates and social allowances.

The Eight-hour Decree limits the hours of work per day but not per week. Sunday rest is, however, provided for under a separate law. No provision regarding the payment of overtime is made in the Eight-hour Decree, but in practice overtime rates are paid.

The Luxemburg State system of social services covers sickness, accident, invalidity and old age insurance, and some provision for unemployment.

The visits to the works showed that the employers, by the improvement of the plants and of their equipment, had reduced manning to a minimum.

The physique and general appearance of the workers were good, and in every department visited the workers were hard at work. With no unemployment, with the further development and improvement of plant and the energy which managements and workers display, a further development in capacity and output is to be expected in

* The Report does not give information regarding wages in the British iron and steel industry, but this information was published in the *Ministry of Labour Gazette* of August, 1926, page 284, where it is shown that the average weekly earnings of workers in the pig iron industry in 1924 was 63s. 1d. and of workers in steel melting, rolling, &c., 61s. 5d. per week. When allowance is made for the difference in hours and the fact that there is no short time on the Continent, it is understood that, for every 100s. paid in Great Britain, Germany pays 67s.; France, 50s.; Luxemburg, 49s.; Belgium, 47s., and Czechoslovakia, 42s. The *Ministry of Labour Gazette* also states that the average weekly normal hours in Great Britain are, at blast-furnaces, 53 net for shift workers, and 46·6 net for day workers, and in steel melting, rolling, &c., 41·8 net for shift workers and 46·7 net for day workers.

future years from the iron and steel industry of Luxemburg. A member of the delegation had visited the principal works during 1923, and was much impressed by the great development which had taken place since then, especially in finished products.

Germany.—There is a considerable degree of similarity between the German and the British iron and steel industry as regards the organisation of the workers in trade unions and the existence of collective agreements.

Despite the rehabilitation of the German iron and steel industry after the war, and the extent to which plants have been improved in their equipment, the industry is suffering from unemployment. Not only employers and their organisations, but the workers and their organisations emphasised the serious competitition from the iron and steel industry of France, Belgium, and Luxemburg, both in the home market and in foreign markets. The high rate of interest charged for borrowed money is proving a serious handicap to the iron and steel industry of Germany.

The recent inquiry into hours of work and wages and earnings carried out by the German Federal Statistical Office, and the information obtained from the employers' organisations, the trade unions and by visits to works, have enabled accurate data to be available as to the earnings of the various classes of workers, and the hours actually worked in the iron and steel industry.

It was found that many of the social and industrial problems which face Great Britain to-day confront the German iron and steel industry, and on all sides opinions were voiced of the difficulties in finding a solution of these various problems.

In Germany, the functions of the Ministry of Labour have a considerable degree of resemblance to the functions of the British Ministry of Labour. The same observations apply with regard to trade union organisation, and the part which trade unions play in the German and British iron and steel industry. In short, it is found that in principle, in policy and in the difficulties confronting the post-war situation of the iron and steel industry, there is a marked similarity between Germany and Great Britain.

It is clear that the loss to Germany of the valuable iron ore mines of Alsace-Lorraine has had a serious effect upon the metallurgical industries of Germany. The determination, however, of the German iron and steel industry to overcome that situation was demonstrated by what was seen and the information obtained as the result of inquiry.

The works visited showed the extent to which Germany had changed over from a war to a peace-time basis, and, further, the improvements that had taken place in the equipment of some of the iron and steel plants. In short, it was clear from information obtained, and as the result of visits to works, that, but for the difficulties which at present confront the German iron and steel industry, its equipment and plant are capable of increased production and development, and, wherever possible, if money is available, steps are being taken still further to modernise and improve existing plants.

Czechoslovakia.—In Czechoslovakia the visits to the works of one large company showed most up-to-date plant and equipment, and excellent works organisation. The interviews with the employers and the leading trade unionists in Czechoslovakia evidenced a cordial relationship existing between employers and workers, and a common mind towards maintaining and developing the Czechoslovakian iron and steel industry. It was interesting to find in the Czechoslovakian Republic evidence of intensive endeavour to maintian its industrial position at the highest point of efficiency.

The system of collective bargaining and collective agreements ensures a measure of standardisation in working conditions, and in so far as the sanction of trade unions is necessary as regards overtime under the hours law in Czechoslovakia, such sanction is freely granted, being considered by the trade union leaders as in the interests of their members and of the industry.

It was noticeable that the trade union leaders and the workers whom they represent did not favour family allowances or the provision of companies' houses at nominal rents. In this connection, they showed a spirit of independence *vis-à-vis* the employers.

The extent to which the Czechoslovakian iron and steel industry has developed since the war is shown by the increase in its annual production of pig iron and steel since 1922. This can be well understood from the visits paid to works, and the types of employers' and trade union leaders and classes of workers who were seen. The physique and general appearance of the workers were good.

It is not too much to say that still further development of the Czechoslovakian iron and steel industry will take place, and that more and more in future years its products, outside the supply of its home demands, will be found in the markets of the world.

Air-cooled Aero-Engines: A Review of Developments in the Past Ten Years.*

By A. H. R. FEDDEN.

THE conquest of the air, or the possibility of sustained flight by heavier-than-air machines, of which man has dreamed since the Athenian Dædalus was fabled to have fitted himself with wings, has only been realised during the present century, and it is the small high-speed internal combustion engine that has made this achievement possible. It is safe to say that the solution of the problem of mechanically sustained flight might have been attained many years earlier if a suitable prime mover had been available which was not only light enough in itself, but also did not consume too great a bulk of fuel.

Although an extremely ingeniously designed steam engine, of very light weight, was produced by Sir Hiram Maxim, and the petrol engine actually used by the Wright brothers was water-cooled, it is no exaggeration to state that air-cooled engines were responsible for making heavier-than-air machines practicable, because other types were comparatively heavy and permitted the carrying of so little fuel that anything but the shortest flights were out of the question.

In France, where aviation made by far its deepest impression in the first years of the present century, a series of air-cooled engines was developed and produced in considerable quantities, the most original type being the "Gnome" air-cooled rotary engine designed by Monsieur Seguin. Prior to 1914, therefore, by far the greatest number of aircraft were fitted with air-cooled engines. The war created a demand for a rapid increase in the power of aircraft engines, to which the rotary engine and the thermodynamic technique of the air-cooled cylinder were not equal, with the result that by 1920 the usually accepted size for general purposes was about 250 to 275 B.H.P., and these engines were almost universally of the water-cooled type.

In spite of this position, however, there were those who believed that provided sufficient time and experimental work were given to the thermodynamic aspect of the problem, the air-cooled engine offered many advantages, and they had sufficient faith in their beliefs to concentrate upon the problems involved. The result of these labours is that in 1930 the air-cooled aero-engine is throughout the world in a considerable ascendancy over the water-cooled type. Apart from the light type of private aeroplane for which the air-cooled engine of about 100 H.P. is universally used, the generally accepted size of aircraft engine is now 500 to 550 B.H.P., or approximately double the power of standard engines of 1920.

Reasons for Air Cooling.—With the great triumph of British water-cooled engines in the Schneider Trophy race still fresh in the minds of all interested in aviation, it is natural to ask: "Why are air-cooled engines fitted to the majority of present-day aircraft? How has it come about that at the present time by far the larger proportion of the Service aircraft of the Royal Air Force employ air-cooled engines? Why is it that the same condition exists in most of the other fighting air forces of the world, while in commercial aircraft, both for the light plane and large air liners, the air-cooled engine is almost universally used?'

There is a psychological aspect to consider when making a cursory review of the merits of the two types of engine. The present generation looks upon the water-cooled engine as the standard power unit for all the large and better class of road vehicles, and air cooling has been associated only with motor cycles and the light type of cycle car; it is also more accustomed to the smooth contours and apparent solidarity of the monobloc water-cooled engine, as compared with the somewhat less neat appearance of the air-cooled engine, and surely, it thinks, on aircraft of all vehicles air-cooled cylinders must be inefficient.

In spite of these apparently sound deductions, it is believed that the air-cooled engine will continue to gain in popularity for aircraft. In America, where, as in the case of the motor car, really large aircraft production prevails, because of the temperament of the people and the great outlet for aircraft, the air-cooled engine is universally accepted. During the last two years over twenty serious manufacturing concerns have entered the aero-engine business, and they are all producing air-cooled engines.

In championing the air-cooled engine it must not be thought that the advantages of the water-cooled engine are not appreciated, and it is believed that there is a definite field for both types. For extremely high speed and ultimate endurance the water-cooled engine offers at the present time advantages that the air-cooled engine cannot give. The reasons are that with the water-cooled engine very fine stream-lining and low drag, compact, wing radiators are possible, and that the higher compression ratio possible enables a slightly better thermal efficiency to be attained and consequently a low specific fuel and oil consumption.

Reviewing the main advantages of the air-cooled engine, it is considered that they should be placed in the following order: (*a*) simplicity; (*b*) light weight; (*c*) absence of a water system and risk of damage by frost; and (*d*) service qualifications—quick get-away, manœuvrability, less vulnerability.

(*a*) *Simplicity.*—It is considered that the outstanding advantage of the air-cooled engine is its simplicity. This term should include low first cost, fewness of parts, ease of repair, ease of installation and engine replacement, and, in the case of the radial type, ease of application of gearing and a supercharger.

In support of this view a statement made by the late Chief of the Air Staff, Marshal Sir Hugh Trenchard, may be quoted. When lecturing three or four years ago to the Cambridge Air Squadron, he said: "In the event of another war the wastage of aeroplanes would be so great that the country which could most rapidly re-equip itself would most probably win the war." Such an authoritative statement alone would seem to justify the retention of the large air-cooled radial engine for general service purposes, for of the known types of engines to-day, it alone offers hope of keeping an Air Force adequately supplied in time of war.

Granted equal manufacturing facilities, an air-cooled radial engine of 450 B.H.P. costs at least 20 per cent. less than an in-line water-cooled engine of equal power, to which must be added, also, the cost of the radiator, water piping, &c.

An air-cooled radial engine of this size has also approximately 20 per cent. fewer parts, but what is more important is that the single-bank radial engine lends itself readily to the employment of forgings for many of the stressed parts. A casting, even of the permanent mould type, is unsatisfactory for such a light and highly stressed structure as an aero-engine. It may be added that in really large production the use of forgings actually reduces the cost of manufacture, an outstanding example being the Ford car. It is believed that this is one of the reasons why most of the best American engines are of the single-bank air-cooled radial type.

The forgings for a radial engine are simpler to make, and easier to handle than the castings of an in-line engine; the simpler problems of material and the fact that the machining operations are less intricate, with more frequent repetition, are considerations of primary importance if new firms, unaccustomed to aircraft engine manufacture, have to be hurried into production.

For the same reasons the cost of repairs is lower also. The times for stripping and rebuilding a radial engine are considerably less than for an in-line water-cooled engine of equal power. The extent of the repair equipment, including jigs, tools, and special tackle, necessary for a repair depôt, is less for a radial air-cooled engine, a matter of prime importance for the outlying base of an air force or a commercial operating company. The air-cooled engine, and especially the large air-cooled radial, can also be installed more easily than the corresponding water-cooled engine which entails the making of water connections, &c.

Supercharging and gearing, both comparatively recent additions to aircraft engines, seem to present less serious dynamic problems on air-cooled radial engines than on water-cooled in-line engines, and fit neatly into the structure of the power unit. It is considered that in both cases this is more a matter of luck than design, and is chiefly due to the short crank shaft whereby serious harmonics are avoided. The air-cooled engine is at a further advantage when employing a supercharger, inasmuch as it has a sufficiently large cooling capacity to deal with the reduced cooling at high altitudes with the amount of supercharging which is practicable to-day. In the case of the water-cooled engine a considerable amount of radiator surface must be added when a supercharger is used.

(*b*) *Light Weight.*—The specific weight of large air-cooled radial engines of from 300 to 600 H.P. is far better than that of any other proved type of aircraft power unit. A modern 450 H.P. air-cooled radial engine complete weighs 30 per cent. less than a corresponding in-line water-cooled engine with an allowance of 0·56 lb. per B.H.P. for water and radiator. In view of the inherently low load-carrying capacity of all aircraft this saving in weight is of the highest importance on all types.

(*c*) *Absence of a Water System.*—The elimination of the water system with its attendant radiator, water pump and piping, is an obvious advantage, but the problem of the "plumbing," as the Americans aptly describe it, goes a good deal deeper.

The tendency for water leaks to occur in a power unit mounted on such a light and "live" structure as an aeroplane is a continuous source of trouble. Up to the time the Imperial Airways Company adopted air-cooled engines, 30 per cent. of their engine failures were attributed to this one cause. Owing to the thin sections of water jackets, radiators, &c., water must be drained in frosty weather on all aircraft lying in the open, a tedious operation on such craft as flying boats.

The efficient working temperature range of an air-cooled engine is two and a-half times that of a water-cooled engine, a matter of great importance in extreme climates, and all the Scandinavian countries have changed to air-cooled engines during the past three years, with marked improvements; the Royal Air Force in Iraq and India have now also been equipped with air-cooled engines.

As an interesting example of flying conditions in Scandinavia, it may be mentioned that military competitions were held in Sweden under winter conditions in the Arctic region. The machines, mounted on skis, were left out in the open all night under a military guard, and the temperature was down to 20 deg. Fah. below zero. When permission was given to commence starting operations the machines with air-cooled engines were in the air in under three minutes, while the best time for a water-cooled engine machine was thirty-eight minutes, and in some cases steam had to be pumped into the jackets before filling up with hot water.

Corrosion is an ever present trouble, and owing to the very thin metal sections employed may be serious; in some very hot countries it is sometimes more difficult to obtain supplies of suitable water than to obtain fuel.

With the introduction of wing radiators as used on the Schneider Trophy racing machines, the water-cooled engine has a considerable advantage over the air-cooled engine in that the surplus heat from the engine is dissipated at a negligible drag; such a form of cooling has not proved practicable up to the present, however, for anything but specialised racing machines. The radiating surfaces are necessarily large and vulnerable and are only a few thousandths of an inch thick. The Americans tried this arrangement on their "Scout" machines, but abandoned it as being too unreliable.

(*d*) *Service Qualifications.*—There are two important service qualifications which the air-cooled radial engine fulfils—manœuvrability and quick get-away. Considerably better manœuvrability is possible with the short air-cooled radial engine than with an in-line water-cooled engine of corresponding power.

Owing to high mechanical efficiency which results from the use of a short shaft, and the shorter warming-up period necessary with air cooling, an aircraft fitted with an air-cooled radial engine can get away very much more quickly than one fitted with a corrresponding water-cooled engine. This is a matter of the utmost importance for a ship's fighter launched from a gun turret, or for a night fighter. The latest types of water-cooled in-line engines require a warming-up period of considerable length, and in extremely cold climates some form of preliminary heating has to be used.

Present-day Air-cooled Aero-engines and their Manufacture.—It will be agreed that the progress of the internal combustion engine during the last fifty years has been one of the outstanding developments of mechanical engineering, and when it is remembered that the early internal combustion engines of fifty years ago weighed 500 lb. per horse-power—even Daimler's high-speed engine, running at about 1000 r.p.m., weighed just 90 lb. per horse-power—and that present-day motor car engines weigh 7 lb. per horse-power, it will be realised that the present production type of air-cooled engine of 500 H.P., weighing under 2 lb. per horse-power, has necessitated considerable research and development. A short description of some of the materials and methods of manufacture of the Bristol "Jupiter" 500 H.P. air-cooled radial engine may therefore merit attention.

This engine is of the static radial air-cooled type and has nine cylinders, 5¾in. bore by 7½in. stroke of 1750 cubic inch capacity. It is made with the propeller drive running at engine speed, also with a reduction gear giving a propeller drive of half engine speed, and for military purposes it is supercharged by a built-in centrifugal blower maintaining ground-level depressions in the induction system at an altitude of 12,000ft.

The selection of materials for the manufacture of high-powered air-cooled engines is a matter of the utmost importance. An aero-engine seldom runs at less than

* The Institution of Mechanical Engineers—Bristol Summer Meeting.

60 per cent. of full power, and for a considerable proportion of its life it runs at 80 per cent. to 90 per cent. of full power. To maintain the low specific weight the material scantlings have to be very closely designed, and to keep down the loading of the main dynamic parts of the engine, such as the pistons and connecting-rods, the sections are such that the stresses are comparatively high. It will therefore be realised that at any cost porosity, slag inclusions, or material defects must be avoided. Wherever possible, and particularly on highly stressed parts, forgings are used in place of castings, as with such thin scantlings castings are found to be unreliable.

The few castings used are made from a special aluminium alloy. Each casting is rigidly examined in detail and test pieces are taken before it is allowed to proceed into manufacture. All castings are heat-treated to remove casting stresses before machining.

Meticulous care is taken in inspecting all raw material before it is passed on to the machining operations. All forgings are Brinell tested, and from every main component, such as the connecting-rod, crank case, &c., tensile and Izod test pieces are taken from each individual forging.

The ingots for the main steel components, such as crank shafts, connecting-rods, and propeller hubs, are "slabbed" and sliced, and the billet machined before drop stamping. For these parts nickel-chrome steel of 65 tons per square inch tensile strength is used. All valve springs are made from polished wire, which is etched with a 3 per cent. solution of nitric acid, and examined in detail before being coiled into springs. The final machining operations require great care and fine finish. All sharp corners must be rigorously avoided, and the smoothest finish on all stressed components is demanded to obviate fatigue failures.

Cylinder barrels are machined from a hollow steel forging and the heads from a "Y" alloy forging. The forgings weigh 60 lb. and the finished cylinder 25 lb. The cylinder barrel is finally honed to a smooth finish. The crank case is made from a duralumin drop forging. Crank case forgings in the rough state weigh 200 lb., and the finished case 73 lb.

The master connecting-rod and articulated rods are machined from nickel-chrome drop forgings to a smooth finish, and are finally polished and etched in a 3 per cent. nitric acid solution to discover if any flaws in the material are present. The single-throw crank shaft with integral main balance weights is made from nickel-chrome steel, the shaft being bored and ground for lightness and smooth finish. The 2 to 1 reduction gear is of the bevel epicyclic type, the gears being made from hardened steel of a tensile strength of 85 tons per square inch.

Owing to the rigid inspection methods which have to be employed throughout the manufacture of an aero-engine, the percentage of scrap is unavoidably high. Tolerances must be rigidly maintained, and such items as screw threads are very carefully checked on all components.

For military purposes, aircraft have to be operated at high altitude, and as the density of the air decreases so the power of the petrol engine falls off. At 18,000ft. a naturally aspirated aero-engine develops half the power it does on the ground, and, to counteract this, supercharging is necessary. The centrifugal blower is driven from the rear end of the crank shaft through a 10 to 1 train of ground gears incorporating a spring drive to damp out cyclic shocks, and with slipping clutches introduced into the planetary pinions to obviate shock loads from excessive acceleration when the throttle is suddenly opened. The impeller is 9¼in. diameter, and as at full throttle it runs up to a speed of 22,000 r.p.m. this unit requires most careful selection of material and workmanship.

After assembly the engines are run for five hours by an electric motor. They are then tested for 3½ hours and are completely stripped and subjected to a detailed inspection of all parts, after which they are assembled and tested finally for two hours.

Before a new type of engine is allowed to go into production many hundreds of hours of development work are necessary, including an official Government test of 100 hours, and extended flight tests.

Future Air-cooled Aero-engine Development.—It may be of interest to indicate some of the most likely developments of this type of engine in the future. The author has deliberately narrowed the scope of his remarks to cover the near future only, as we are probably a long way from the standardised aircraft power unit, and the discovery of new materials may bring about radical changes resulting in an engine of a design outside our present conception, or the successful evolution of a type not at present considered as a prime mover for aircraft purposes. As aircraft differ greatly according to their purpose, engines will have to be designed for special purposes, and definitely divided into military and commercial types. For light commercial planes the in-line air-cooled engine has given exceptionally good service, and air cooling is universally used for this purpose.

It is believed that for some time to come these types of engine will hold the field. In America the six-cylinder in-line air-cooled engine of similar power has been developed, and in inverted form it provides a new power unit with the minimum amount of resistance. For this category of aircraft several attempts have been made without success to produce an air-cooled two-stroke engine, with its obvious advantages of simplicity and light weight; with the introduction of supercharging and possibly direct fuel injection this may prove a likely line of development.

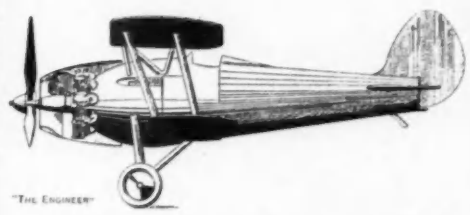
For commercial aircraft of moderate size and for training machines the air-cooled radial engine is very widely used in all countries. The Wright "Whirlwind" nine-cylinder 300 H.P. radial engine is extensively used in four and six-cabin passenger machines, and has been employed in the Transatlantic flights.

For military aircraft and commercial work the 400–500 H.P. air-cooled radial aero-engine, such as the Armstrong-Siddeley "Jaguar," the Bristol "Jupiter," and the American Pratt and Whitney "Wasp," are widely used.

Up to the present air-cooled in-line engines of this size have not been successful owing to cooling problems, and it is believed that by the time these engines are satisfactorily cooled by suitable air ducts the resistance will be practically the same as that of the radial engine, while the latter has the advantages of light weight and simplicity of construction outlined above.

During the last year or two the introduction of completely cowled radial air-cooled engines promises to mitigate the greatest objection to this type, namely, that the air flow in passing the engine cylinders becomes thoroughly disturbed. The desirable clean stream-line flow is thereby considerably broken up, and as the disturbance continues past the structural part of the aircraft parasitic resistance is caused.

The accompanying engraving gives a view of a completely cowled radial engine. The cowling is of stream-line form in itself and in relation to the fuselage; it permits the entry of only sufficient air for cooling purposes. This cooling air finally passes out through a circumferential gap, to join with the minimum of disturbance, the larger portion of the air stream, which travels smoothly over the



COMPLETELY-COWLED ENGINE INSTALLATION

external cowling skin, and continues in a similar manner over the fuselage. A considerable improvement in the performance of aircraft is obtained as a result of this development.

In the near future a 1000 H.P. air-cooled engine will be required for both military and commercial work, and it is believed that the compression ignition engine has a considerable future. So much has been promised for the compression ignition aero-engine of late years that there is some scepticism concerning it. For the smaller types of power unit referred to previously it certainly does not seem extremely hopeful, although compression ignition engines of 225 H.P. are being produced in America. It would appear that to cope with the additional stresses of a compression ignition engine the specific weight will have to be at least 50 per cent. higher than for the corresponding petrol engine, and for power units of 800 H.P. or under this is a very serious consideration. There is also the question of smell, and creep from the fuel, and it is expected that this type of engine must run comparatively roughly, with serious effect on such a light structure as an aeroplane. When, however, one considers the requirements of a large aircraft remaining in the air for considerable periods, where the lower fuel consumption of approximately 25 per cent. would be of the utmost value, it is believed that the compression ignition engine will come into its own. The author's firm have been experimenting for some time on a single-cylinder air-cooled compression ignition unit of 7⅞in. by 12in. and 512 cubic inch capacity, and the results have been very promising. This single-cylinder unit has given an output of 80 B.H.P. with a fuel consumption of 0·43 lb. per B.H.P.-hour.

The aero-engine manufacturer is always looking for better and lighter materials, and his developments must always depend on the materials available. Much is hoped from "nitralloy" steel, and from lighter non-ferrous forgings, such as magnesium, to prolong life and reduce weight.

Canadian Engineering News.

(From our own Correspondent.)

Bounty on Iron Ore.

To encourage the production of iron in the province of Ontario, the provincial Government has decided to provide a bounty of 1 cent a unit on iron ore mined and smelted in the province. If one-half of Ontario's present consumption of pig iron was from ore mined in the province, the total bonus to the industry would be about 350,000 dollars a year. At the present time every ton of iron produced in Canada comes from imported ore. Ontario possesses practically unlimited deposits of low-grade ore, distributed over a wide area in the North. At present Canada produces over 1,000,000 tons of pig iron annually, and Ontario is credited with nearly 80 per cent. of that. Of the 95,000,000 dollars invested in the industry in Canada, 60,000,000 dollars are invested in Ontario. In 1927 Canada produced 525,000,000 dollars worth of iron and steel products and Ontario's share was 375,000,000 dollars. The total consumption of iron and steel products in Canada that year represented a value of 750,000,000 dollars and Ontario's consumption was 70 per cent. There is known to be a bountiful supply of iron ore in the James Bay district, near the lignite coalfields, at present being investigated by the Government. Water power is plentiful in that district, and the union of these resources hold the promise of a new era to both new and old Ontario.

Will be Ready for R 100.

The Dominion Government officially announces that arrangements for receiving the R 100 will be in readiness when the airship arrives towards the end of this month. The mooring mast at St. Hubert, near Montreal, is completed and the work is going ahead on the other facilities. The huge supply of hydrogen which the ship will require has to be provided, a plant for producing the gas and gasometers to hold it have to be installed. Another important provision is a water supply. This will have to be pumped to the top of the 200ft. tower.

Fertiliser Plants Advanced.

The Consolidated Mining and Smelting Company's new fertilizer plant near Trail, British Columbia, will be in operation in the autumn of 1931 and will produce 360 tons of sulphuric acid daily. Construction is well under way and work is to be rushed. The addition of this plant marks an important phase in the company's operations, which thus will be extended beyond the metallurgical field into the chemical field. Pure hydrogen, oxygen and nitrogen will be among the primary products, and ammonia will be produced by the Fauser synthetic method. The ammonia has to be combined to make some stable salt, such as ammonium sulphate, ammonium phosphate, ammonium nitrate, or other compounds containing ammonia. The sulphuric acid for this work will be obtained from the zinc roaster gases. It will be used in direct combination with ammonia to make ammonium sulphate and by interaction with phosphoric rock to make phosphoric acid.

Coking Plant.

The Dominion Natural Gas Company has secured a 53-acre site at Port Stanley, Ontario, for the erection of a 3,000,000 dollar coking plant. The new plant will have a capacity of 2000 tons of coal a day. It will produce 7,000,000 to 9,000,000 cubic feet of gas daily.

Railway Extensions.

The Canadian Pacific Railway plans to spend more than 50,000,000 dollars during the present year on new equipment, new branch line construction and improvement to existing equipment and road bed. In keeping with its permanent policy of intelligent expansion, the company will continue its programme of providing additional rail facilities in all parts of Canada. In this connection approximately 10,000,000 dollars will be expended in Western Canada on the enlargement of terminals, branch lines and general provision for increased efficiency. This will include the laying of 240 miles with 100 lb. rails, the continuing of rock ballasting between Fort William and Winnipeg, and the building of a tunnel at Vancouver to connect the Burrard Inlet terminals with the False Creek yards. In addition, the company will continue the construction of branch lines into the North-West, where settlement is rapidly increasing and mining and exploration work is being carried on.

Michipicoten Coal Dock.

Paper mills, railways and mining operations are large consumers of coal in the districts of Algoma, Cochrane, the western part of Sudbury, and the eastern part of Thunder Bay district, in North-Western Ontario. To provide cheaper transportation for this coal, which is brought by boat from the North-Eastern United States, the Algoma Central Railway decided to develop the already partly developed Michipicoten Harbour as a coal dock. This greatly reduces the rail haul, as previously this coal had to be trans-shipped at Sault Ste. Marie.

Michipicoten Harbour was developed originally about 1900 to serve the iron mines, and is connected to the main line of the railway by a branch. The old dock was demolished in 1928, and in the winter of 1928 and 1929 a survey of the harbour was made, soundings being taken through the ice. Rock was found at depths of from 22ft. to 55ft. It was then decided to build wooden cribs to be sunk 5ft. below the dredged channel. These cribs, and the space immediately behind them, were filled with iron ore waste which was obtained from a nearby source. The remainder of the fill, an area about 300ft. wide and 500ft. long and triangular in shape, was filled with gravel obtained from a high bank alongside the track about 7 miles distant. The dock top was built on a continuous line along the top of the cribs and tracks laid on the raised fill behind the dock front. On the runways of the coal bridge 100-lb. Canadian Pacific Railway section rail was laid. The coal bridge is a rope trolley steam operated type, the framework being of stout steel construction. It is designed to unload stock, reclaim and load out bituminous coal at the rate of 500 net tons per hour.

THE INSTITUTION OF MINING ENGINEERS.

THE following programme has been arranged for the general meeting of the Institution of Mining Engineers, which is to be held at Birmingham on Wednesday, Thursday and Friday, July 9th, 10th and 11th next.

On the Wednesday, at 11 a.m., there will be a General Meeting at the University, when the Members will be welcomed to Birmingham by the Lord Mayor (Alderman M. L. Lancaster, J.P.). The Chair will be taken by the President (Mr. H. Eustace Mitton, M. Inst. C.E., F.S.I.). The following papers will be submitted for discussion:—(1) "The Introduction of Machine-mining at Newdigate Colliery," by D. S. Newey; (2) "A Comparison from the Standpoints of Economics and of Practical Working between Compressed Air and Electricity for use in Collieries," by Professor Douglas Hay, and N. E. Webster (this paper was written by the authors at the request of the Council of the Institution, for submission to the Second World Power Conference, Berlin, June, 1930, in response to an invitation from the Papers and Participation Committee of the Conference); (3) "The Application of Briquetting to the Production of Domestic Fuel," by J. R. Homer; (4) "The Cleaning of Coal: An Experimental Determination of the Fundamental Principles of Pneumatic and Wet Separators," by A. A. Hirst; (5) "The Settling of Fine Coal in Water, with Special Reference to the Clarification of Washery Water," by L. W Needham; (6) "The Occurrence and Estimation of Lead and Zinc Compounds in Coal," by Professor K. Neville Moss, A. A. Hirst and L. W. Needham; (7) the First Progress Report of the Committee of the Midland Institute of Mining Engineers on "The Control of Roof and Support of Mine Workings: The Beeston Seam of West Yorkshire."

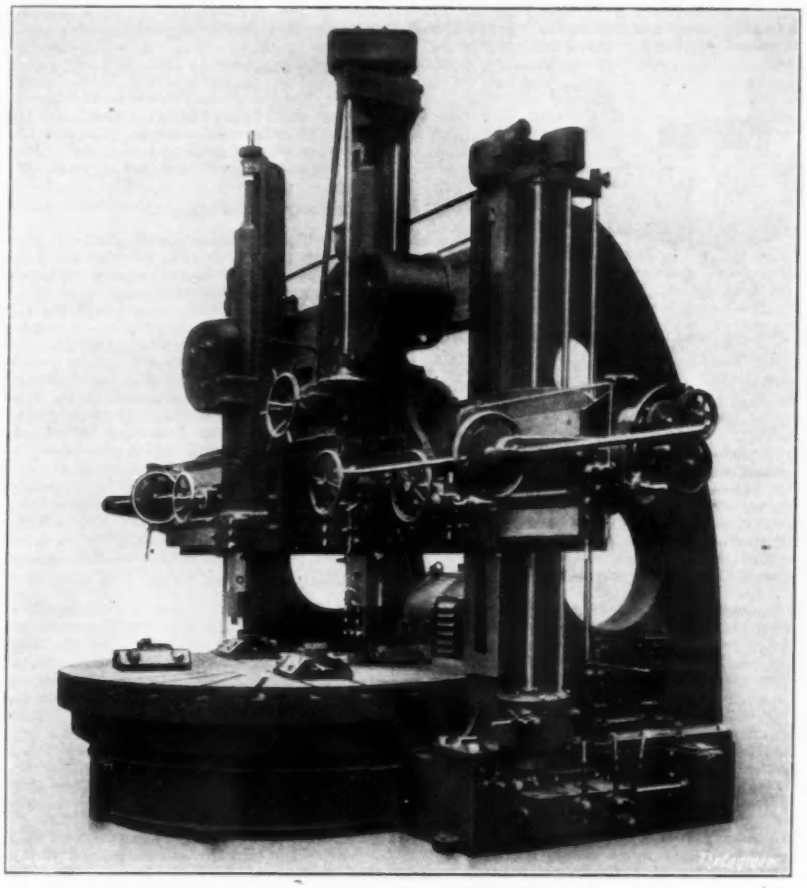
The proceedings will continue throughout the day. In the evening there will be a Conversazione and Dance at the University at the invitation of the University Authorities.

On the Thursday there will be alternative excursions to (1) the Coventry Colliery of the Warwickshire Coal Company, Ltd.; (2) to the Witton Works of the General Electric Company, Ltd.; (3) to the Electric Power Station at Hams Hall; and (4) to the Cocoa and Chocolate Works of Cadbury Brothers, Ltd., Bournville.

On the Friday, there will be an all-day excursion through the Cotswold and Shakespeare Country, Chipping Camden, Broadway, Cheltenham and Stratford-on-Avon.

A LARGE BORING AND TURNING MILL

JOHN HETHERINGTON AND SONS, LTD., MANCHESTER, ENGINEERS



A Large Boring and Turning Mill.

THE accompanying illustrations represent a 12ft. boring and turning mill, which, together with two others of similar capacity, and one to admit up to 9ft. in diameter, have recently been built by John Hetherington and Sons, Ltd., Manchester. The machine, which embraces some special features, is driven by a 40 horse-power variable-speed motor, with a speed range of 3 to 1, which, with a four-speed gear-box, gives twelve table speeds from 0·5 to 13·5 revolutions per minute. The gear wheels are all of cut steel and are immersed in an oil bath, the box being totally enclosed and having covers over the shaft ends to retain the oil. Motion is transmitted from the gear-box to the table ring, through a steel worm and bronze wheel at the back of the machine, an illustration of which is given. The worm gearing runs in oil and the worm shaft revolves in ring-lubricated bearings, the end thrust being taken on ball-thrust bearings.

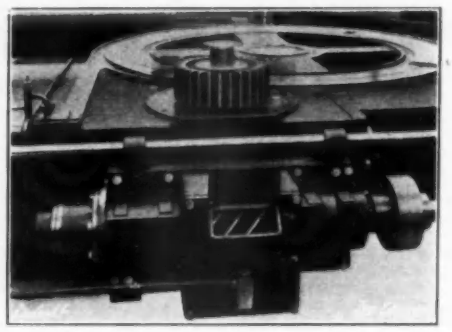
The bed is of box pattern, having the faces planed to receive the uprights and to form the flat circular track for the table to turn upon. The lubrication of the table race is by oil under pressure from a pump operated by the worm shaft, grooves being provided for the circulation of the lubricant, and there are also oil wells and self-acting roll lubricators for the effective distribution of the oil over the surfaces. Troughs are provided all round the track, both inside and outside, for conveying the oil back to the pump, and the centre of the bed is bored out to receive an adjustable bush for the table spindle, which is bolted to the table, and is fitted into the bush in the bed. In order to overcome any tendency to lift, a thrust washer is fitted to the bottom of the spindle, and the diameter of the spindle at the top of the cone is 21in.

The uprights are of box pattern with long bases securely tongued into the bed and the front faces are planed to receive the cross slide. The uprights are bolted at the top to a box-section cross stay which carries the driving gear for elevating the cross slide and for the rapid power motions to the ram slides and rams. The dimensions of the uprights are as follows:—Width of body, 12in.; width of face, 16in.; base, 7ft. long from front to back.

The cross slide is also of box section, with a deeply arched double-wall back. It is raised and lowered by power.

The ram saddles, one right and one left hand, are entirely independent. The saddles have narrow guides for maintaining alignment. The ram slides are arranged to swivel through an angle of 45 deg. on either side of the vertical, the operation being effected by worm and worm wheel and steel quadrant. Stops are provided to locate the slides when the rams are in the vertical position, and the quadrants are indexed, while a vernier is fitted for fine setting.

The rams are of steel, spring balanced, and of octagonal section. They are provided with hand and power feed and rapid traverse motions in all directions, the self-acting traverse being 5ft. The tool holders are of forged steel designed to accommodate two tools simultaneously for boring, turning, and surfacing. They have parallel shanks fitted into and close up to the ends of the rams, the latter being split and fitted with a number of clamping bolts. Means are provided to prevent the tool holders dropping out of the rams inadvertently. Positive continuous and reversible feed motions are fitted to each ram in both the horizontal and vertical directions. These

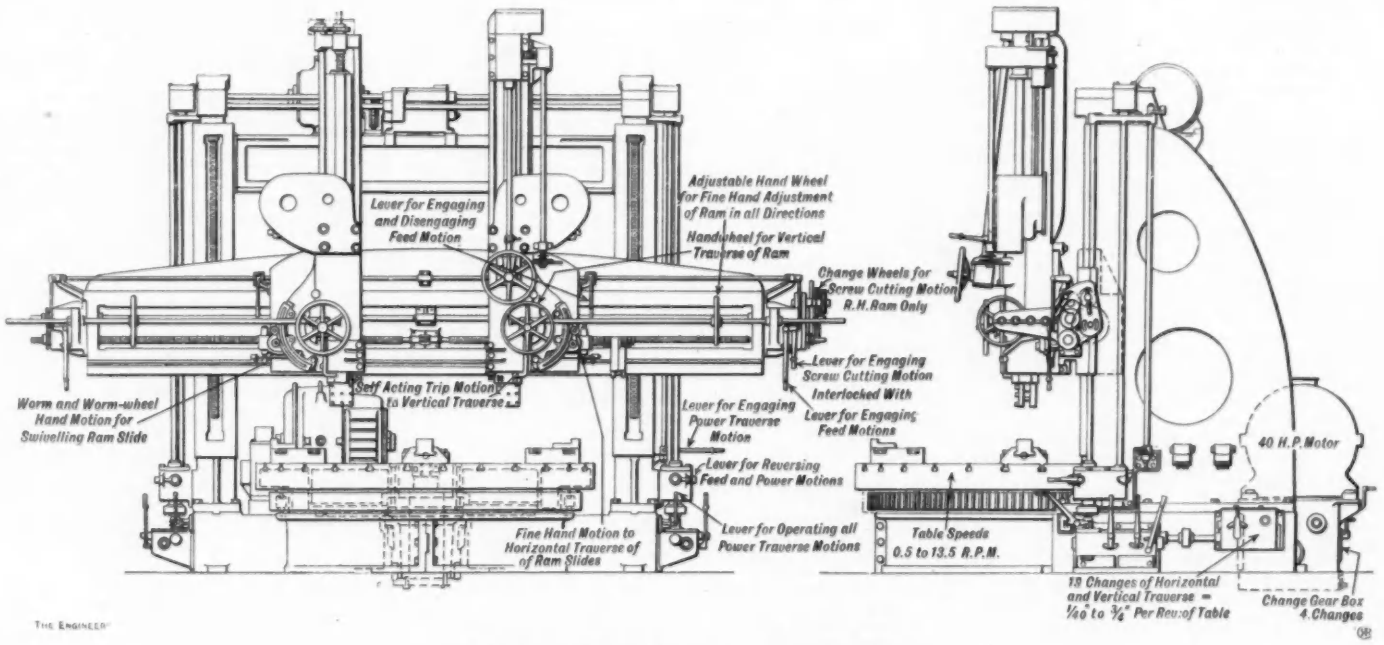


WORM DRIVE FOR TABLE

motions can be quickly changed while the machine is in operation by means of indexed hand wheels. Sixteen changes of feed from one-fortieth to three-quarters of an inch per revolution of the table are possible, and all the feeds can be engaged or disengaged from the working position at the ram slide. The vertical feed motion of the rams is applied by means of a screw down the centre of each, and there is an automatic trip. A conveniently-placed hand wheel, adjustable to any desired working position, operates the fine hand feed motion in either the horizontal or vertical direction. Rules and verniers are provided on the ram slides and micrometer index dials are fitted on all the feed screws and shafts.

For elevating and lowering the cross slide and for rapid traversing of the ram saddles and rams in all directions, power motions are provided, a separate constant-speed reversing motor of 15 horse-power being mounted on the cross stay and fitted with safety slipping clutches to prevent damage by faulty handling.

In addition to the motions previously mentioned, a screw-cutting motion is provided on the right-hand ram, and change wheels are supplied for cutting threads with pitches varying from ¼in. to 2¼in. As stated above, the table race and pinion shaft bearings have forced feed lubrication, while all the other bearings are oiled on the group system by sight feed mechanism.


Lever for Engaging and Disengaging Feed Motion
Adjustable Hand Wheel for Fine Hand Adjustment of Ram in all Directions
Handwheel for Vertical Traverse of Ram
Change Wheels for Screw Cutting Motion R.H. Ram Only
Lever for Engaging Screw Cutting Motion Interlocked With Lever for Engaging Feed Motions
Worm and Worm-wheel Hand Motion for Swivelling Ram Slide
Self Acting Trip Motion to Vertical Traverse
Lever for Engaging Power Traverse Motion
Lever for Reversing Feed and Power Motions
Fine Hand Motion to Horizontal Traverse of of Ram Slides
Lever for Operating all Power Traverse Motions
40 H.P. Motor
Table Speeds 0.5 to 13.5 R.P.M.
13 Changes of Horizontal and Vertical Traverse = 1/40" to 3/4" Per Rev. of Table
Change Gear Box 4 Changes
THE ENGINEER

ARRANGEMENT OF BORING AND TURNING MILL

All the electrical equipment has been supplied by the General Electric Company, Ltd. The machine, exclusive of the electrical equipment, weighs about 60 tons.

IT is reported that Mr. William Beebe, of the New York Zoological Society, has reached a record depth in the sea of 800ft. in a steel ball fitted with fused-quartz windows. This feat was carried out at Hamilton, Bermuda.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

THE iron and steel and engineering industries in the Midlands and Staffordshire continue to find business dull, trading conditions not having altered appreciably on the week. The attendances on 'Change in Birmingham have been small and sellers have predominated. The decision of steelmasters and of ironmasters to maintain the present level of prices has naturally not tended towards an improvement in buying, but, on the other hand, it is extremely doubtful whether any reduction which could be made by producers would be sufficient to infuse new energy into current demand. The basic industries of the area, almost without exception, are slow, and even seasonal trades are operating below normal. The summer quietude seems to have definitely set in.

Raw Iron Prices Upheld.

The Central Pig Iron Producers' Association has caused increased dissatisfaction by its decision to maintain selling prices at the level fixed eight months ago, despite a fall of some 6s. per ton in the cost of furnace coke. Users are very strong in their condemnation of the smelters' action, claiming that the argument that a reduction would not resuscitate trade is no reason for keeping prices at an artificial level. Sales of both foundry and forge grade iron are reported to be falling away further, and stocks are accumulating at the furnaces. Purchases are made only for current consumption and tonnages are very small. Midland furnaces are able to maintain output so far, but there is some talk of damping down unless matters mend. On 'Change in Birmingham to-day—Thursday—Derbyshire No. 3 foundry iron was quoted £3 18s. 6d., Northamptonshire foundry £3 15s. per ton delivered in the Black Country zone. Forge iron was quoted 4s. per ton less in each case. Furnace coke prices are weak and a plentiful supply is available. While some ovenmen are quoting 13s. to 13s. 6d. per ton, it is believed that an offer of 12s. 6d. would be accepted.

Steel.

Little comment has been made this week upon the decision of the Steelmasters' Association not to reduce prices, nor has business been noticeably interfered with. It is questionable whether buyers would have responded to a price concession. Stocks at the consuming works seem to be ample for current needs, and users are not inclined to buy material for problematical future requirements. In few instances can engineers see far ahead and orders are in most cases being completed quicker than fresh ones are coming in. Structural engineers in particular, complain of the shortage of work. Steel works, owing to the smallness and diverse nature of orders, have difficulty in arranging rolling programmes. Output from Midland steel works is about maintained at recent levels. Values are as a week ago, angles £8 7s. 6d., tees £9 7s. 6d., joists, £8 10s., ship, bridge and tank plates £8 17s. 6d., all subject to rebate. Boiler plates sell at £9 12s. 6d., small bars at £8 to £8 15s., mild steel billets at £6 upwards, delivered, and Staffordshire hoops at £10 at works. Competition in the half-products branch is as keen as ever, and merchants dealing in foreign steel continue to quote low prices, but without attracting any great volume of business.

Staffordshire Bar Iron.

Staffordshire best grade bar iron continues to sell steadily at £12 10s. per ton, and mills are able to maintain fairly continuous operation. In other branches of the wrought iron trade, however, lack of orders makes it extremely difficult for works to be kept going. Crown bar makers quote from £10 to £10 10s. per ton for their product, but little business comes their way. Common bar makers are even less fortunate, being quite unable to compete with continental competitors. Wrought iron tube strip sells steadily at £11 2s. 6d. per ton. Galvanised corrugated sheets are in slightly better request, and values are upheld on the basis of £11 17s. 6d. per ton for corrugated sheets of 24 gauge. One or two of the overseas markets have shown a little more sign of life, and inquiries suggest some substantial business as being in the offing.

Important Rationalisation Scheme.

A working arrangement, likely to be far-reaching in its effects, has been entered into between the two important engineering firms of R. A. Lister and Co., Ltd., of Dursley, Gloucestershire, and Ruston and Hornsby, Ltd., of Lincoln, Grantham, and Stockport. The arrangement, which affects twelve companies, does not involve the merging of financial interests. The object is to secure efficient co-ordination in design, production and sales. The parties to the arrangement control subsidiary and associated companies in Canada, the United States, France, Belgium, Germany, Australia, and the Argentine. The individual firms affected, while retaining their identity, will be greatly strengthened by the close working which the arrangement ensures, and the manufacturing and selling resources of the whole will be devoted to securing a substantially greater share of overseas trade for British engineering products. The works of the two firms cover over 400 acres, and their combined assets are estimated at over £6,000,000. It is understood that Mr. G. R. Sharpley, the managing director of Ruston and Hornsby, will join the board of Lister and Co., Ltd., and that Mr. Percy Lister, the managing director of R. A. Lister and Co., Ltd., will join the Ruston and Hornsby board.

Engineering Trade Depression.

"With the ever-increasing world-wide depression, it is not possible for me to anticipate any improvement in trade during the current year." This remark of Sir Sydney H. H. Penn, made at the annual meeting of the Horseley Bridge and Engineering Company, in Birmingham, is far from encouraging, and local industrialists, though they would like to gainsay it, are compelled to recognise its truth. Business in this branch is decidedly dull, and Sir Sydney pointed out that so far as his firm was concerned, they would probably be better off by closing down certain branches of the business. The deliberate policy of the directors, however, was to keep the works going with a view to increasing production, and, pending an improvement in the world's markets, to concentrate on the reduction of costs and the development of manufacturing processes.

The Industrial Outlook.

Sir Francis Joseph, the President of the North Staffordshire Chamber of Commerce, at the annual meeting of that body, said trade conditions were very depressing. The outlook was one of unrelieved gloom. He sometimes thought that as a nation we were suffering from what was termed an inferiority complex. We were frightened, we had lost the spirit of adventure, and we had lost faith in our industries. If that was our mental attitude towards trade and industry, a trade revival would not come. We must have a change of heart and of mind. The latter portion of his remarks are commended to Midland pessimists who, unfortunately, are far too numerous just now.

Birmingham Uses More Electricity.

The consumption of electricity in Birmingham continues to increase, and sales of current during the past year amounted to nearly 358,000,000 units, or an increase of 13¾ per cent. on the preceding year's output of 314,500,000. The number of new consumers connected with the mains during the twelve months was 11,792. These new supplies, coupled with extensions to existing consumers, added an equivalent of 109,342 60-watt lamps and approximately 32,000 H.P. in power connection to the supply system. The maximum demand during the year was 160,500 kW, compared with 145,200 kW last year, and load factors in the respective periods were 29·6 per cent. for 1928–29 and 30·6 per cent. for 1929–30. The surplus on the year's working was £175,539, compared with £168,435 in the preceding year.

Contracts for Midland Firms.

The Metropolitan Cammell Carriage, Wagon and Finance Company, Ltd., of Saltley, Birmingham, has received from the Crown Agents for the Colonies a contract for eighty bogie covered goods wagons for service on the Kenya and Uganda Railway. This company is also constructing two articulated underframes and bogies for a new saloon coach for the use of the Governor-General of South Africa. The Sentinel Waggon Works, Shrewsbury, has received an order for two standard 200 H.P. steam rail cars, with two trailers, for the Buenos Aires Midland Railway. Morris Commercial Cars, of Birmingham, are to supply to the Indian Government 236 bodies for 30-cwt. Morris six-wheeled lorries. The Daimler Company, of Coventry, has recieved an order for fifty single-deck saloon omnibuses from the Lancashire Traction Company.

To Aid Coventry Industries.

The Coventry Corporation Electricity Undertaking, having made the substantial profit of £21,235 on the year's working, proposes to turn its attention to the assistance of bulk supply consumers and, realising the existing trade difficulties, it recommends the City Council to grant a special discount of 7½ per cent. off the accounts for electricity supplied, from April 1st last, on the high-tension or bulk supply system. There is to be a condition governing this special discount, which is additional to the discount of 5 per cent. allowed for payment within twenty-one days of demand, and that is that it is to be computed monthly and to be allowed if the number of units of electricity supplied to the bulk consumers as a whole is not less than 92½ per cent. of the number of units so supplied during the corresponding month in the preceding year. The recommendation is the outcome of applications from industrialists for a revision of existing charges and of various conferences between the parties concerned.

Loss on Cannock Chase Coal.

There was an average loss of 6d. per ton on all coal produced in the Cannock Chase and Pelsall coalfield during May, compared with a loss of 1·03d. a ton in April and a profit of 1s. 0·96d. a ton in March. Towards the 42 per cent. on the 1911 wage basis that the coalowners have to pay to the miners, the capacity of the industry to pay is only 22·95 per cent. Wages during July will remain as last month, stallmen getting a minimum of 9s. 6d. a shift, loaders 8s. 6d., and able-bodied surface workers 6s. 8d. The owners' accumulated deficit, which was £1,187,094 a month ago, is now reported as £1,217,512.

Bilston Firm's Centenary.

Midland industrialists have this week been offering their congratulations to the firm of William Lewis and Son, Mount Pleasant Works, Bilston, on the reaching of its centenary. The firm was established in 1830 by Mr. William Lewis, who began as a blank tray manufacturer and japanner. He later commenced the manufacture of air pipes, used in the ventilation of mines, and to-day the firm is famed throughout the country and abroad for these pipes. During the long period the firm has been in existence, it has had only two principals—father and son.

Unemployment.

Employment in the Midlands continues to sink, and the number of idle hands increases. The latest unemployed returns give a total for the area of 267,288, as compared with 264,800 a week previous. Of the total, no less than 184,231 are male adults, while there are 73,288 women without work. In the Birmingham area the total has advanced in a week from 40,765 to 43,748, while increases are also recorded at Coventry, Derby, Leicester, Nottingham, Redditch, Smethwick, Tipton, and Walsall. In the Stoke-on-Trent area there was a decline, the figures falling from 29,333 to 27,999, while Wolverhampton's unemployed were less on the week by 684.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Saving in Overheads.

SOME idea of the practical economies in overhead charges resulting from a large-scale industrial merger was given at the recent annual meeting here of Manchester Collieries, Ltd. Early last year the company was formed for the purpose of amalgamating a number of Lancashire coalmining undertakings, the total capital of the new concern amounting to nearly £5,500,000. The net profit from March 12th, 1929, to March 31st last was £108,215, and after paying the dividend on the 7 per cent. preference shares the sum of £17,568 is carried forward. The ordinary share capital of the company totals £4,247,585. Not all the possible benefits of amalgamation were enjoyed during the period covered by the financial report, but, briefly, by effecting economies in transport, higher pithead prices were obtained, and there were savings in costs of administration and distribution, which, however, are expected to be more pronounced during the current financial year. On the mining side, the economies that have accrued were principally the results of developing those collieries on which most profit is made and temporarily closing others, while the company is largely increasing the amount of coal got by mechanical means. With a view to securing greater efficiency in connection with machinery and plant an engineering department has been set up. A reorganisation of the buying department and a reduction in the number of concerns from which goods were purchased have been the means of effecting savings in the cost of supplies.

An Engineering Merger.

Manchester district is directly concerned by the announcement of an engineering trade merger which has been made by the directors of Hans Renold, Ltd., a private concern, with works at Burnage, Manchester, to the effect that a provisional agreement had been reached for the "co-ordination of the interests" of the company and those of the Coventry Chain Company, Ltd. At the time of writing no details have been made known.

More Capital for Electrical Engineers.

A public issue was made on Tuesday of this week of 250,000 7 per cent. cumulative preference shares of £1 each in Ferranti, Ltd., electrical engineers, of Hollinwood and Stalybridge. The additional capital, which brings the total preference shares to 450,000, is required to meet the cost of plant extensions that have been carried out and to provide the necessary funds for business developments.

Preparation of Road Material.

It is reported locally that a site is being sought in the Manchester district for the erection of a works for the treatment of natural asphalt for roadmaking purposes, the raw material being imported from the East Indies. Distribution is to be by means of four-ply paper containers.

Electrical Plant for Southport.

Application is being made to the Electricity Commissioners by Southport Corporation Electricity Committee for permission to borrow £20,000 for the purchase of a new switchboard, a Manchester tender having been provisionally accepted.

Non-ferrous Metals.

The movements of the non-ferrous metals this week have not all been in the same direction. In the opening days of the present week tin has shown some reaction after the somewhat firmer tendency that had previously been in evidence, and compared with a week ago values in this section of the market are lower by about £1 a ton. This, however, is not an important matter in itself, although it denotes continued instability. The trouble in this section, as it has been for a considerable time, is that in spite of curtailment talk, demand for the metal lags behind supplies. World stocks of tin are on a very heavy scale and both trade and speculative buying is on quiet lines. A moderate tonnage of refined copper has been taken by the cablemaking and electrical industries, but here, also, the buying movement is much below normal There has, however, for the third week in succession, been a recovery in values, standard cash at the moment of writing hovering round the £50 mark. Rather more interest has been displayed in the case of lead and, statistically this metal seems to be better situated than the rest. At the moment the tendency is reasonably firm, although there has been little actual change compared with a week ago. Spelter is cheaper again and only a quiet demand has been reported this week.

Iron and Steel.

During the past few days there has been the usual beginning-of-the month increase in the number of small orders placed for pig iron. This, however, has been in accordance with expectations and sellers attach no special significance to it. The tonnage going into consumption locally is only moderate and until there is a marked change for the better at the foundries, there is little likelihood of improved market conditions. Meanwhile, prices are at 77s. per ton, delivered Manchester or equal, for Staffordshire and Derbyshire, from 94s. to 95s. for Scottish, and about 89s. per ton for West Coast hematite. The demand for bar iron is on strictly hand-to-mouth lines, with values held at £10 5s. per ton for Lancashire Crown quality and £8 15s. for seconds. Steel rollers offering on this market report little improvement in conditions in any section,

constructional engineering still being the most disappointing branch of the trade. Among locomotive engineers, one or two are specifying for moderate quantities, but for the most part new buying, in this as in most other sections, is extremely limited. Boiler plates are quoted at about £9 17s. 6d. per ton, general plates at £8 17s. 6d., small re-rolled bars at £7 17s. 6d. to £8, sections at £8 7s. 6d. and joists at £8 10s.

Manchester Electricity Supply.

The accounts of the Manchester Corporation Electricity Department for the year ended March 30th last show a revenue of £624,597, compared with £621,893 for the previous year. The sales of current realised £1,755,543, made up as follows:—Lighting and power, £1,370,493; traction, £175,300; street lighting, £65,711; bulk supplies, £144,039. To this has to be added £32,131 from other sources, making a total of £1,787,674. From this amount the working expenditure takes £1,117,033, leaving a balance of £670,641, from which again has to be deducted £624,597 for interest, sinking fund and income tax, leaving a net surplus of £46,044. The quantity of energy generated in kilowatt-hours was 495,726,000, and the quantity sold 392,983,029 kilowatt-hours; the quantity used on the works was 32,809,761 kilowatt-hours, making the total accounted for 425,792,790 kilowatt-hours. The quantity used in distribution or otherwise not accounted for was 69,933,210 kWh, or 14·11 per cent. of the amount generated. The total maximum demand excluding the supply from the batteries was 159,710 kW. The average price of fuel taking the stations as a whole rose from 166d. per ton, the level of the preceding year, to 167d. per ton, and the consumption totalled 344,272 tons. The average weight of fuel consumed per kilowatt-hour of electricity sold was 1·96 lb., as compared with 2·03 lb. in the previous year. Cooking by electricity shows a considerable increase. The number of hired cookers is now 6114, an increase of 932 during the year.

BARROW-IN-FURNESS.

Hematite.

There is no improvement in the hematite pig iron trade and very soon, unless there is a sudden improvement, it is very evident that there will have to be damping down. In certain works where the steel departments are still engaged the margin of iron available for the open market is not great; but the outlook in the steel trade is so bad that there are insufficient orders to keep the mills going for more than a few weeks. At other works iron stocks are increasing. The Continent still continues to be a customer, mostly for better qualities, but the tonnage is not heavy by any means. There are some who think that buyers are taking iron on the hand-to-mouth principle and are holding back orders for forward delivery in the hope of forcing down prices. On the other hand, many believe that customers are not requiring heavy deliveries, which is more than likely. There is not much change at present in the iron ore trade, but the outlook is far from bright. Foreign ore is easier and that may be due to freights coming down. The steel market is dull. There was a shipment of steel rails from Barrow to Cape Town last week. Workington is at present completing the Argentine and South African contracts.

Shipbuilding.

Vickers-Armstrong, Ltd., will launch from their Barrow yard during the next week, the flotilla leader H.M.S. "Keith." Nothing is known in Barrow of the rumoured order for a second Cunarder, which, it is said, will be built on the Tyne.

SHEFFIELD.

(From our own Correspondent.)

No Sign of Improvement.

THE continued depression in most branches of the Sheffield steel trade is now becoming an old story, and one feels inclined to tell it as briefly as possible, and, instead of dwelling on the familiar general details, to deal with special matters of interest. At the moment, the open-hearth steel trade is quieter than ever, only about one-third of the furnaces in Sheffield and the immediate district being in operation. The Lincolnshire trade in crude basic material, although better than Sheffield, appears to be dwindling and its condition now is very different from what it was up to a few months ago. It is thought that stocks in the hands of steel consumers must have run very low, and that a buying movement should develop with the turn of the quarter, but there is no sign of this at present, as inquiries are on a very limited scale.

Special Steels.

The demand for special steels is better than that for bulk steel, but is considerably below its best. The provision of steel and tools for the automobile industry, although it has fallen off from its peak, is still a valuable and considerable branch of local trade. Sheffield continues to be associated with the development of aircraft, and to produce materials for the parts that are subjected to the most severe wear and stress. The latest instances of this to be announced are that Ambrose Shardlow and Co., Ltd., had the machining of the crank shaft of the R 101 airship, and also manufactured, machined and finished completely the crank shaft with which Miss Johnson made her wonderful flight to Australia in her "Moth" aeroplane. The demand for stainless, non-corrodible and heat-resisting steels, and also for cold-worked steels, is, as previously reported, still substantial, though here again a reduction has to be reported when a comparison with last year is made. There is a fair amount of business in Sheffield's best special steels, which have been greatly improved during late years. There is a sale for these materials in all countries where engineering is carried on, but at present the orders are for comparatively small quantities.

Armament and Railway Work.

The time when armament manufacture formed a leading branch of Sheffield's heavy trade has gone by and naval programmes now mean comparatively little to the city. The scheme of replacement announced by the First Lord of the Admiralty last week will, however, bring some work to Sheffield, though not a great deal this year, as the immediate expenditure is not expected to be large. There are no special orders for railway tires, axles or springs to report this week, and the plants engaged on the production of these requisites are only moderately employed. The home railway companies continue to specify quantities rather in excess of last year's, but the quantity of work from overseas in meagre. Some rolling stock orders, in which the Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., is concerned, are announced. That company is to supply, to the order of the Crown Agents for the Colonies, 80 bogie covered goods wagons for service on the Kenya and Uganda Railway. It is also to provide two articulated underframes and bogies for a new saloon coach which is being built in the South African Railway workshops for the use of the Governor-General, the Earl of Athlone.

Efficient Plants.

After all the criticisms which have been levelled at this country's steel plants, and the advice on modernity and efficiency that has been presented to those who control them, the report of the Economic Advisory Council is very satisfactory. That Council, which visited the Continent to investigate conditions in the iron and steel industries, issued its report last week and announced its conclusion that British iron and steel works are not inefficient. Sheffield and district knew that before, with regard to its own plants, but is pleased to have this official confirmation. Mr. Walter Dodgson, the Sheffield Divisional Secretary of the Iron and Steel Trades Confederation, confirms the Council's conclusion, particularly so far as it applies to what is generally known as the bulk steel trade. He cites, as one example of a local plant which is as efficient as anything to be found on the Continent, the Templeborough rod mill of the United Steel Companies, and other plants which may be similarly characterised are those of the Park Gate Iron and Steel Company, the Normanby Park Works at Scunthorpe, and the post-war plate mills of the United Steel Companies at Appleby.

Sheffield Helps Egypt.

The first steel foundry in Egypt has just been established by the Port Said Engineering Company, largely with Sheffield help. Mr. G. C. Castle, a director of Beecroft and Partners, Ltd., of Sheffield, has just returned after superintending the equipping of the foundry. The contract to supply the whole of the plant as well as materials and to act as technical advisers was given to his firm. The capacity of the foundry is about 30 tons of castings per week. The Port Said Company, which is a British undertaking, carries on the business of engineers, ship repairers and brass founders. In the past the castings have been imported from Central Europe, but it is now intended to produce them in the country, utilising as raw materials supplies of good scrap for which there has been little or no market hitherto.

Sheffield and South America.

A good deal of attention has recently been devoted to the question of trade between Sheffield and South America, and now the city is to send an important mission to the Continent in the hope of strengthening business relations. This decision has been come to by the Chamber of Commerce, and the weight which the mission will carry may be gathered from the fact that the Master Cutler—Mr. A. K. Wilson—has consented to undertake it. The mission was suggested by members of the d'Abernon Commission and is approved by the Department of Overseas Trade, who will render assistance through their organisations in the countries to be visited. The main object is to take advantage of the favourable atmosphere created by the d'Abernon Commission, to bring Sheffield goods prominently before all classes of buyers in South American countries and to obtain full particulars of the requirements of those markets.

Reducing Domestic Smoke.

W. H. Micklethwait and Co., Ltd., of Rotherham, are making a kitchen range of a new type, invented by Mr. G. W. Southern, a well-known local engineer, the object of which is to reduce domestic smoke and fuel consumption. The inventor claims that the smoking period of the chimney is reduced 60 to 75 per cent. below that of the ordinary open fire-grate. Tests have shown that smoke is only emitted for a few minutes after lighting up, and that afterwards the chimney is smokeless. The fire burns in a highly incandescent state and produces little ash, owing to an original design of grate which secures smokeless conditions of combustion. It is of the semi-enclosed type and the more complete combustion of the fuel is obtained by the generous admission to the fire of naturally induced and pre-heated air, provided by a simple pre-heater incorporated within the combustion zone of the fire-box. The device is automatic. The fire can be operated with any kind of fuel and will burn domestic rubbish.

From Steam to Electricity.

Owing to a necessity for reducing the cost of power for rolling, Brown Bayley's Steel Works, Ltd., Sheffield, is converting the drive of a 27in. reversing mill from steam to electricity. It has placed an order with the English Electric Company, Ltd., for the whole of the necessary electrical plant and apparatus. Many alternative schemes and equipments were inspected, both in this country and on the Continent, and it was decided that the electric drive, employing energy supplied by the Sheffield Corporation, would be the most economical. The mill rolls high carbon and alloy ingots of 23 cwt. down to billets and small sections, and when the change-over takes place it will be directly driven by a single electric motor having a present maximum output of 6000 B.H.P., but so designed that this output may be increased to 12,000 H.P. by the addition of further generating capacity.

Corporation Contracts.

The Electric Supply Committee of Sheffield City Council is buying a considerable number of transformers and have accepted the following quotations:—British Electric Transformer Company, Ltd., 115 air-cooled transformers of various sizes, from 1 kVA to 180 kVA, for changing from two-phase to three-phase, £1498; English Electric Company, Ltd., six 300 kVA, three-phase transformers, £1029 12s., and five 450 kVA, three-phase transformers, £1118 16s. 3d.; Bruce Peebles and Co., Ltd., two 300 kVA, three-phase transformers, £350; C. A. Parsons and Co., Ltd., four 450 kVA, three phase transformers, £914. Other Sheffield Corporation contracts include one with W. H. Blake and Co., Ltd., of Sheffield, for steel work required in stanchions, roof principals and girders, for the covering of an open yard at Bramall-lane garage, £1060, and one with the Staveley Coal and Iron Company, Ltd., for 4in. concrete-lined pipes, £400.

NORTH OF ENGLAND.

(From our own Correspondent.)

Another Steel Works Fusion.

THE firm of Dorman, Long and Co., Ltd., the Tees-side iron and steel combine, has acquired an interest in the Tees-side Bridge and Engineering Company, of Cargo Fleet, Middlesbrough. This latest fusion does not altogether submerge the individuality of the absorbed company, for it will continue to operate under the same management, and Mr. Arthur Dorman and Mr. Charles Mitchell will join the board of directors. The Tees-side Bridge and Engineering Works was founded more than eighty years ago, and it has been termed the pioneer of the engineering industry on Tees-side. The company built the major part of the plant for the local steel works which was necessitated by the growing use of steel in place of iron. It was in the van of early iron and steel bridge-building firms, and its name is associated with some of the best known bridges which have been built in this country, in India, and in the Colonies. Keeping the works fully equipped to deal with modern requirements, a keen watch has been kept on such developments as the increasing use of steel tanks for oil storage, wireless masts, transmission towers for the electrical grid scheme, and the construction of large buildings with structural steel. In the foundry department ingot moulds are manufactured for use in the local steel works and large contracts have been carried out for British, colonial, and Indian railways.

Big Shipbuilding Order.

As announced in my letter last week, the Furness Shipbuilding Company, Ltd., of Haverton Hill, has been negotiating for a contract for two large tanker whalers, and it is now officially confirmed that the contract has been definitely placed with the firm for the construction of these two vessels. They will be the two biggest ships ever built on the Tees. Each of them will be 21,500 tons deadweight capacity, and will be fitted with twin-screw quadruple-expansion engines. They are to be built for Norwegian owners, but it is definitely stated that they will be of all-British steel. Not the least satisfactory feature of the contract, therefore, is that it will give a fillip to the local steel industry, in addition to the large volume of employment which will be provided for skilled shipyard craftsmen. The Furness Company only recently launched a vessel of similar type and almost equal dimensions. She is now nearing completion, and no doubt the craftsmanship of the Tees builders of these special type of vessels has influenced the placing of this latest contract.

Export Trade Slump.

The general depression in the iron and steel trade at home and abroad is reflected in the steady decline in the Cleveland export trade. Not since July, 1927, has so small a tonnage of pig iron been shipped as in the past month, and the home demand being equally limited, it has become necessary to effect a drastic reduction in the output. Two more blast-furnaces have ceased to operate during the month. The aggregate tonnage of iron and steel shipped from the Cleveland district in June was 57,546 tons, which compares with 62,833 tons in May and 80,991 tons in March. This is the lowest total since January, 1927, when the industry was crippled by the coal strike. Steel shipments are no worse than in April and May, but there has been a significant contraction in the trade with Australia, owing to the imports ban, and India, where high tariff walls have to be surmounted. This decline has been offset by bigger shipments to the Argentine. The pig iron shipments totalled only 12,456 tons. The exports to Scotland fell short of 5000 tons, and only trivial quantities have been shipped abroad.

Cleveland Iron Trade.

The Cleveland iron market shows not the least sign of animation, and the outlook is very perturbing. In addition to the stoppage of a furnace at Consett, there is an early prospect of further reduction of the output of hematite by additional blast-furnaces going out of action. The Cleveland ironmasters are firm in their refusal to cut prices, and probably they are right in their view that a reduction would not materially increase the demand. Home industries are slack, and the markets abroad are too disturbed to offer an outlet for any substantial quantity of iron. No. 1 Cleveland pig iron is 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is very disappointing. Stocks are being augmented at a disquieting rate, and are believed to be approaching 100,000 tons. Sales are very difficult, even at the unremunerative rates named. It is difficult to ascertain the

lowest rates on which contracts might be arranged, but makers are offering ordinary East Coast brands at 71s., though cost of output is quite 4s. above that figure. No. 1 quality is put at a premium of 6d. per ton.

Iron-making Materials.

Business in foreign ore is virtually at a standstill, and it is difficult to secure reliable quotations. Blast-furnace coke is abundant, and sales are not easy to make. Producers are accepting unprofitable figures for prompt lots, but declare they will cease to produce rather than enter into extensive forward contracts at prices obtainable. For early delivery to local users, good average qualities are no more than 16s. 6d.

Manufactured Iron and Steel.

Demand for manufactured iron and steel remains disappointing. Producers of shipbuilding requisites are only moderately employed, and manufacturers of most other descriptions of material are getting well through work on hand. A few orders for semi-finished commodities are reported, despite severe foreign competition. Prices are unchanged.

The Coal Trade.

Another month has drawn to a close, and has been so far as the North of England is concerned, the worst of the year. The experience in the past six months has been one of declining demand for fuel, but June showed the greatest falling off in orders. There is a world contraction in the demand for fuel, and this district is feeling the effect of it in a serious degree. Very few pits are now working full time. It is impossible to say when the demand will revive, as there is an abundance of coal everywhere. Poland has now got such a strong hold in what were once Northumberland's markets that experienced men in the trade believe that Northumberland's best days are over. In every area the booked business is far below what the pits could produce. To keep the pits working even for three or four days per week and to sound the market, sellers of many classes of Durham gas coal and coking fuel are offering concessions of 3d. per ton. The Northumberland steam coal position is very dull. Best qualities are offered at 13s. 6d. for large and 10s. for small. The Wear values are easy, and best large steam quoted at 15s. 3d. and small at 12s. 6d. Tyne primes or similar are at 12s. 9d., and smalls 10s. 6d. The prospects for July give little encouragement, and values, of course, are in buyers' favour. Any good Durham screened are obtainable at 12s. 9d. to 13s. 3d., and for bunker qualities at 13s. to 13s. 3d. Superior class bunkers are nominally held for 14s. Wear best qualities of gas coal can be obtained at 15s. 6d. to 15s. 9d., and secondary qualities at 12s. 9d. to 13s. 3d. There is nothing passing to test the prompt coke position, and values are nominally easy. For autumn shipment speculators inquire freely, and whilst offering enhanced values have not advanced to the makers' ideas. The latter, although finding definite business scarce, are holding steadily, and for patent coke ask a minimum of 18s., and for gas coke 21s. 6d.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE amount of tonnage launched from Clyde shipyards last month is the largest June output since the 1906 record of 124,544 tons, excluding the war years. The C.P.R. "Empress of Britain," of 42,500 tons, accounted for almost half of last month's total output of 91,157 tons. Altogether, there were eighteen vessels of over 100 tons gross each launched from Clyde yards last month, also a number of smaller craft. All over the river the position is rather quiet at present, and there are too many vacant berths, but the outlook has improved in certain areas, with the placing of orders for two P. and O. liners, a large motor tanker, and a contract for the construction and installation of exhaust steam turbines on the Bauer-Wach system in seven of the Clan Line's larger vessels. With regard to the new Cunarder, it is pointed out that some months must necessarily elapse before the actual work can be commenced. It has also been mentioned that when the keel of the motor tanker referred to above has been laid down that all the berths in the yard of the builders—the Blythswood Shipbuilding Co., Ltd.—will be occupied.

Steel and Iron.

On the whole, nothing has happened during the past week likely to create much interest with regard to the immediate future of the steel and iron trades. Doubtless, recent shipbuilding contracts will exert a beneficial influence later on, but meantime there is nothing to become enthusiastic about. The markets present an almost lifeless appearance. Short time is all too prevalent, and outputs are restricted. Black steel sheets have a moderate turnover, but galvanised descriptions are very slow. The demand for small tubes is still disappointing, and here, again, broken time is prevalent. Conditions in bar iron and re-rolled steel bars are most depressing. The former continues nominally unchanged in price, while the latter, though reduced to what is considered an unremunerative level at about £7 12s. 6d. per ton home or export, has not secured any benefit in the way of increased turnover. Pig iron shows no change, business continuing on very restricted lines. Here also quotations are reckoned hardly a paying proposition.

Scrap.

The market for scrap has fallen flat. Prices are on much easier levels at 52s. 6d. to 55s. for heavy steel, about 55s. heavy basic, and 65s. per ton for cast iron machinery.

Coal.

General conditions in the coal market are unchanged. Land sales are on a very meagre basis, with the result that the collieries in Lanarkshire especially are having a very lean time. In all districts round fuels are in plentiful supply, despite reduced outputs, and in several instances fair-sized lots can be secured through second-hands at cheaper than colliery prices. In all districts washed nuts maintain a fairly firm appearance, owing to restricted supplies. Aggregate shipments amounted to 245,878 tons, against 232,258 tons in the preceding week and 259,586 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade.

DESPITE the fact that the day-to-day conditions continue to be so devoid of interest, shipments of coal from this district keep up very well. Last week there was a slight improvement as compared with the figures for the preceding week, as, according to the Great Western Railway's returns, the total was just over 560,000 tons, as compared with 542,000 tons. Yet the return of idle tipping appliances showed that about the middle of last week the number was twenty-six, and by Saturday morning it had reached the unusual total of fifty-three. It is evident that some very good loading work is being accomplished, which is not altogether surprising in view of the fact that so much coal is standing and ready to be shipped, and collieries are only too glad to secure the quick release of wagons. There is no doubt that the majority of undertakings are working with considerable irregularity, and it is impossible to avoid this, in view of the general slackness of the demand for prompt loading. It is difficult to see how the conditions for the next few weeks can show any improvement, as undoubtedly the chartering of tonnage is well below the average, and new orders are slow to come along. The prospect of shipment figures for the current week being as good as last week is not promising, as on Monday the number of idle tipping appliances was forty, which is high for the beginning of the week, and shows that the week-end arrivals of tonnage were very disappointing. Unfortunately, all the inquiries that come on the market do not result in definite orders for Welsh coals. The competition from continental producers, particularly from Germany, is intensely keen. Apart from shipments of coal to foreign coaling stations being well below the normal, business for Spain is at a very low ebb at the present time, this being very largely due to the depreciation of the peseta, which is now standing about 44–45 to the £, as compared with about 30 twelve months ago.

Miners' Affairs.

The annual conference of the South Wales Miners' Federation passed off last week rather quietly. Although the delegates passed a very considerable number of resolutions, these appear to have attracted less than the usual amount of attention. The resolutions dealt with the conditions to be incorporated in a new wages agreement, rationalisation, piecework, holidays, silicosis, pensions, and numerous other subjects, but there can be no doubt that the matter most in the minds was the question as to what is to be the fate of the Mines' Bill. A statement covering the whole situation was given to the delegates by Mr. T. Richards, the general secretary, and a resolution was passed protesting against the insidious agitation carried on by the coalowners, ostensibly in the interests of the miners, respecting a shorter working day under the 7½ hours Act. The miners were warned that by this move it was intended, by lengthening the other working days, to re-establish the eight hours and weaken the demand for a return to the seven hours. Incidentally, the balance sheet of the Federation for last year shows an improvement upon that for 1928. The average membership was 74,466 as against 59,858. Contributions, including the political levy, amounted to £56,475, as compared with £45,424. Income from other sources amounted to £6182, so that the total income amounted to £62,656, while the expenditure for the year came to £50,423.

Hours for Coal Tipping.

Representatives of the coal trimmers and tippers at South Wales ports again met the representatives of the employing interests at Cardiff on Monday last on the question of the demand of the men for the abolition of night work and the reversion to the system of two continuous day shifts. There was again no agreement between the parties, as the employers declined to give way on the question of the maintenance of the present system. Following upon the conference there was a meeting of the representatives of the workmen, when it was decided to refer the whole question back to the unions for further consideration. There is no doubt that the leaders feel that they are in a difficult position. The rank and file have already instructed the leaders to take the necessary steps to terminate the present system of work, but the leaders hesitate to adopt drastic measures, such as giving notices and thereby bringing about a serious situation and possibly a strike. Probably what the men really want is extra payment for working night-time.

Tin-plate Works Close Down.

At the end of last week nine mills at the Cwmfelin tin-plate works, Swansea, stopped work, with the result that all are idle. Operations will continue in the finishing department until the stocks are exhausted, so that in a few weeks the whole works will be at a standstill, unless there is a favourable development with regard to the representations which are being made to the directors of Richard Thomas and Co., Ltd. There are nineteen mills at these works, ten of which were stopped several weeks ago. Normally, the works employ about 1000 men.

Traffic Returns.

The G.W.R. Company's returns of sea-borne traffic at the six ports in this district under their control for the four weeks ended June 8th reached a total of 2,783,371 tons, which compares with 2,440,575 tons for the preceding month and with 2,801,333 tons for the corresponding period of last year.

Current Business.

The conditions on the steam coal market display very little, if any, change. Large coals are plentiful, but sized qualities are firmer, due partly to a slightly better demand, and to the fact that production of these coals is more restricted. Coke is extremely quiet, and patent fuel shows no improvement. Pitwood shows a tendency to be firmer, as the result of a reported strike at Bordeaux, which, if it lasts any time, will mean that supplies of wood coming along will be reduced.

LAUNCHES AND TRIAL TRIPS.

MEDOC, steamship; built by David and William Henderson and Co., Ltd.; dimensions, 236ft. by 34ft. by 16¾ft.; gross tonnage, 1200 tons. Engines, triple-expansion, 18in., 30in. and 50in. diameter by 35in. stroke, pressure 200 lb. per square inch; constructed by the builders; launch, May 30th.

ALCIDES, motor tank ship; built by Barclay, Curle and Co., Ltd., to the order of D/S. A/S. Eikland; dimensions, 460ft. by 59¾ft. by 34ft.-1in.; to carry oil in bulk. Engine, opposed-piston, airless injection, four-cylinder, two-cycle, 3000 B.H.P.; constructed by the builders; launch, June 26th.

GUAYRA, motor ship; built by A. and J. Inglis, Ltd., to the order of the Argentine Navigation Company, Ltd.; dimensions, 181¼ft. by 36ft. by 8¼ft. Engines, two sets of six-cylinder, single-acting, trunk type, airless injection; launch, June 26th.

MAYON, steamship; built by Vickers-Armstrongs, Ltd., to the order of F. L. Duff and Co.; dimensions, 340ft. by 50ft. 3in. by 25ft. 7in. Engines, two sets of Parsons turbines, pressure 230 lb. per square inch; launch, June 26th.

SILVERSANDAL, motor ship; built by Harland and Wolff, Ltd., to the order of Stanley and John Thompson, Ltd.; dimensions, 455ft. by 61¾ft. by 40ft.; gross tonnage, 6200. Engines, two single-acting Diesel; constructed by the builders; launch, June 26th.

TRETIS, steamship; built by Wm. Gray and Co., Ltd., to the order of E. Hadjilias; dimensions, 403ft. 6in. by 53ft. 9in. by 25ft. 8¼in. Engines, triple-expansion, 24½in., 41in. and 68in. diameter by 48in. stroke, pressure 200 lb. per square inch; constructed by the builders; trial trip, June 26th.

CATALOGUES.

JAMES TATE AND CO., Victory Works, Bradford.—Details of the Tate system of electric valve control.

RUSTON-BUCYRUS, Ltd., Lincoln.—General catalogue R.B. 1018, dealing with many types and sizes of excavating plant.

SULZER BROS., 31, Bedford-square, W.C. 1.—A booklet illustrating the working and some installations of bore-hole pumps.

IGRANIC ELECTRIC COMPANY, Ltd., 149, Queen Victoria-street, E.C. 4.—Leaflet No. 1600, "Pulley Type Magnetic Separators."

WESTINGHOUSE BRAKE AND SAXBY SIGNAL CO., Ltd., 82, York-road, N. 1.—A booklet on the braking of trolley omnibuses.

DIESEL ENGINE USERS ASSOCIATION.—The Committee of the Diesel Engine Users Association has decided to offer a prize for a paper contributed during the year 1931. The prize, which will consist of a medal and the sum of 25 guineas, will be awarded for the paper of the year which is considered to be of the greatest value to the Diesel engine user. The award will not be restricted to members of the Association.

LLOYD'S REGISTER SCHOLARSHIP.—This scholarship, which is awarded annually by Lloyd's Register of Shipping on the results of an examination held in May under the auspices of the Institute of Marine Engineers, has this year been won by Mr. Wilfred Thompson, of Tynemouth, an apprentice engineer with the North-Eastern Marine Engineering Company, Ltd., Wallsend-on-Tyne. The scholarship is of value £100 per annum, and is tenable for three years at a British University.

UNIVERSITY OF BRISTOL.—From a prospectus of the Faculty of Engineering, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, that has just reached us, we notice that courses of study are available at the College for persons intending to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and diplomas in engineering subjects are also included in the prospectus, which can be obtained from the Registrar of the Merchant Venturers' Technical College, Bristol.

SOUVENIR OF A ROYAL VISIT TO TEES-SIDE.—To mark the visit of H.R.H. the Prince of Wales to Middlesbrough to open the Constantine Technical College on July 2nd, the Tees-side Chamber of Commerce prepared a special souvenir, in the form of an illustrated brochure dealing with the industrial activities of the neighbourhood. After a foreword by the editor—Mr. S. A. Sadler Forster, A.C.A.—there is first of all a description of the Technical College, the founding of which is due to the generosity of the late Mr. Joseph Constantine and his family, which is followed by a history of the Middlesbrough Chamber of Commerce. Then, in addition to sections devoted to "The Romance of the Tees" and "The Shipping Facilities of Tees-side," there are sections dealing with the river Tees and its ports, Middlesbrough and its port, Stockton-on-Tees, Thornaby-on-Tees, the County Borough of Darlington, and the Hartlepools. In each case there are illustrated references to some of the more important manufacturing concerns in the various districts, upwards of fifty separate undertakings being included. The whole forms a most instructive review of Tees-side industries.

INSTITUTION OF AUTOMOBILE ENGINEERS—SUMMER VISIT.—The 1930 summer visit of the Institution of Automobile Engineers was devoted to inspections of the river Thames and of shipping. Leaving Westminster Pier on June 26th on a special launch, some fifty members and their ladies steamed down the river, an official of the Port of London Authority explaining the various places of interest passed on the way. The P.L.A. had arranged that, on reaching the King George V. Dock, the launch should be permitted to look-in—by means of a lock designed to take the largest steamers using the Port—and steam up and down the dock, which was lined on both sides with big steamers and motor ships trading to all parts of the world. The launch then proceeded to the Albert and Victoria Docks, which were similarly lined with big ships, and after inspecting a tobacco warehouse containing about 40,000,000 lb. of tobacco in bond, it went on to Tilbury to allow the members to see over a 20,000-ton P. and O. liner. Next day the party changed over to a motor coach and went to Chatham to inspect a 4000 H.P. cruiser, and the visit concluded with a return trip up the river and a visit to the training ship "Worcester."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	18/6 to 20/-
(1) Spanish	20/6 to 22/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (*c.i.f.*)	20/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 19 6	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 10 0	3 10 0
Siliceous Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 0	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	4 5 6 (*a*) / 4 8 6 (*b*) / 4 12 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 17 6 to 8 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 0 0 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	135 12 6
„ (three months)	137 12 6
Copper (cash)	50 0 0
„ (three months)	49 10 0
Spanish Lead (cash)	18 1 3
„ „ (three months)	18 1 3
Spelter (cash)	15 18 9
„ (three months)	16 11 3
MANCHESTER—	
Copper, Best Selected Ingots	56 0 0
„ Electrolytic	56 10 0
„ Strong Sheets	83 0 0
„ Tubes (Basis Price), lb.	0 1 0
Brass Tubes (Basis Price), lb.	0 0 11
„ Condenser, lb.	0 1 1
Lead, English	19 7 6
„ Foreign	18 0 0
Spelter	16 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/-
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/-
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£39 0 0	15/-
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	13/3
„ „ Splint	14/- to 15/-
„ „ Trebles	12/6
„ „ Doubles	12/-
„ „ Singles	11/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/3
„ „ Jewel	16/-
„ „ Trebles	12/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	10/3 to 12/9
Screened Navigation	16/6 to 17/6
Trebles	13/- to 14/-
Doubles	11/6 to 12/-
Singles	11/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/6
Secondary Steam	11/-
Trebles	13/-
Doubles	11/6
Singles	11/3

ENGLAND.

(8) N.W. COAST—	
Steams	20/6 to 21/-
Household	32/- to 51/-
Coke	21/- to 21/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/-
Steam Smalls	10/- to 10/6
Unscreened	13/-
Household	25/- to 37/-
DURHAM—	
Best Gas	15/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/- to 28/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	25/- to 26/6 —
Derbyshire Best Bright House	20/- to 22/- —
Best House Coal	19/- to 20/- —
Screened House Coal	17/- to 19/- —
„ „ Nuts	15/- to 17/- —
Yorkshire Hards	14/- to 15/6 —
Derbyshire Hards	14/- to 15/6 —
Rough Slacks	8/6 to 9/- —
Nutty Slacks	7/- to 8/- —
Smalls	3/- to 5/- —
Blast-furnace Coke (Inland)	15/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	17/- to 18/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	20/-
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/-
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/6 to 17/
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/6 to 13/-
Washed Nuts	19/- to 22/-
No. 3 Rhondda Large	20/6 to 21/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	16/- to 16/6
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	27/- to 37/-
Furnace Coke (Export)	21/- to 21/6
Patent Fuel	22/- to 22/6
Pitwood (ex ship)	27/- to 28/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	27/6 to 31/6
Red Vein	23/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	40/- to 46/-
Beans	24/6 to 27/6
Peas	20/- to 21/-
Breaker Duff	10/- to 10/6
Rubbly Culm	12/3 to 12/9
Steam Coals:	
Large	19/6 to 20/6
Seconds	18/- to 19/6
Smalls	12/- to 13/-
Cargo Through	15/6 to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Shipbuilding.

THE situation of the French shipbuilding industry is reviewed in the annual report of the Chambre Syndicale des Constructeurs de Navires et de Machines Marines. It appears that the industry is really starting upon a period of reorganisation, the report declaring that the official investigation has now been terminated and that the task of putting the recommendations of the Comité National Economique into effect must be carried out forthwith. The shipyards will first of all create an organising body which will decide upon what is to be done to concentrate the interests of shipbuilders with a view to bringing down costs, and, when a workable scheme has been evolved, a permanent commercial company will be formed by shipbuilders to centralise business. There is, obviously, much to be done to retrieve the unsatisfactory situation of shipyards. Last year France launched and had under construction 81,607 tons, which placed her sixth amongst shipbuilding countries. At the same time, twenty-six vessels were purchased abroad, representing 70,300 tons. Had that work been kept at home the shipyards would all have been employed. During the first half of the present year, not a single new order, it is declared, had been given out to French shipyards, but since the report was issued the Compagnie Générale Transatlantique has confirmed the order placed with the Chantiers Penhoët at Saint Nazaire for a 60,000-ton liner, which is to be put on the stocks in the autumn. The new combined lock and dry dock at Saint-Nazaire is being specially constructed to allow the ship to leave the yard, while it will also permit of the biggest vessels being dry docked. One of the objects of the organising body now being formed, is to settle upon a method of standardisation of practically everything entering into the construction of ships. That is already being done in the case of hull fittings and auxiliary machines, while arrangements are being made with the mills and forges to standardise sections used in shipbuilding. It is also hoped to cheapen the construction of fishing boats by reducing the number of types to three or four. The law passed last year rendering compulsory the carrying out of repairs in French yards on condition that French prices do not exceed the foreign by more than 100ft. per ton, and allowing of the free importation of raw material necessary for repairs, has greatly improved the situation of shipbuilders, but it is partly set off by the suppression of taxes on the importation of ships purchased abroad by French owners. Builders are unable to secure complete protection because it is a matter of policy that shipowners should not be required to pay more for vessels than their competitors abroad.

Railway Deficits.

When the Government withdrew its guarantee for the payment of interest on railway debentures and required the companies to create a common fund to pool all the profits, the system appeared to work satisfactorily so long as there was a balance on the right side. If there was any falling off it seemed a simple matter to bring up the fund to a desired figure by increasing the railway rates. All was well enough during the period of prosperity when the traffic receipts expanded, but three or four years ago the fund began to deplete and an increase in the rates brought it back again to an adequate figure. The year 1929 was not a good one for the railway companies, for while the situation of some of them was fairly satisfactory, the losses incurred by others made a heavy drain on the fund, which became very low. As matters have become worse it is fairly certain that during the present year the fund will disappear altogether unless the companies again raise the railway rates. Everyone is anxious to avoid that contingency at a time when the industrial future depends upon bringing down prices and costs, and it is all the more undesirable because it would coincide with the operation of the new social insurance scheme, which, it is generally agreed, must have some effect upon prices by imposing an additional burden on industry. The Conseil Supérieur des Chemins de Fer is, therefore, by no means disposed to authorise the companies to increase the rates, which would be extremely unpopular, but the companies state that the only alternative will be for the Government to suppress the heavy taxes on traffic receipts, which it is believed, would suffice to provide the necessary surplus for the common fund.

The Claude Power Scheme.

As stated recently, Monsieur Georges Claude cabled home from Cuba to the effect that the work of laying the new tube in Makansas Bay in order to draw cold water from the depths and utilise the difference of temperature between it and the surface water for the production of energy was proceeding. That cable has been followed by another stating that, for the second time, the tube has been destroyed. On the first occasion it broke and sank in a rough sea. It now appears that the floats supporting the tube during erection gave way and let the tube fall to the bottom. The corrugated tubes of large diameter were sent out from France in sections. As they were joined up they were pushed out on floats, and as the total length was something like 3000ft., it is obvious that the operation was only possible in a perfectly calm sea. Monsieur Claude is by no means disheartened by this disaster, and has announced his intention of immediately constructing another tube and of selecting a more appropriate time of the year for its immersion. If the figures given of the expenditure already incurred are correct the experiment must have been very costly.

Motor Cars.

The falling off in the export of motor cars is seriously affecting the two leading firms which had gone in for mass production. They have decided to close down for some weeks during the holiday season. Since the beginning of the year, business has been very slack, and it is clear that the home market is unable to absorb a production that was intended mainly for export. The increased import duties seem to have had the effect of checking the importation of American cars, but for the moment that is not helping home makers, who have experienced a bad season's trade and can see no hope of improvement.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

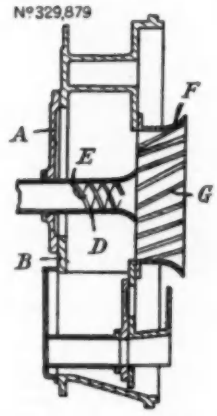
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

329,879. June 29th, 1929.—FURNACE FRONTS, James Howden and Co., Ltd., of 195, Scotland-street, Glasgow, and James Howden Hume, of Caxton House, Westminster, London, S.W. 1.

This invention relates to improvements in furnace fronts applicable to furnaces devised for burning oil or either coal or oil. The door A mounted on the front plate B carries a burner

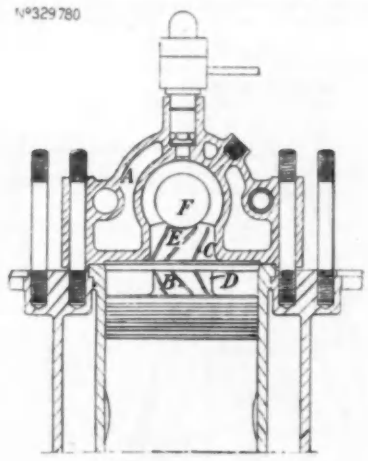


pipe D, adopted to replace the existing oil burner and serving for the admission of pulverised coal together with the primary air. Within the pipe D there is a helix in the form of twisted strip metal. The pipe is fitted with a regulating valve and preferably it is adjustable in an axial direction. F is a flared director or guide for the secondary air, formed with helical vanes G. The secondary air supply is controlled by valves—which are not shown in the illustration.—*May 20th*, 1930.

INTERNAL COMBUSTION ENGINES.

329,780. April 15th, 1929.—OIL ENGINES, Colin Hugh Macmillan and Robert Angus Macmillan, both of Temple Works, Anniesland, Glasgow.

A four-stroke oil engine is provided in accordance with this invention with means for imparting a swirling movement to the gases compressed in the chamber A. For this purpose

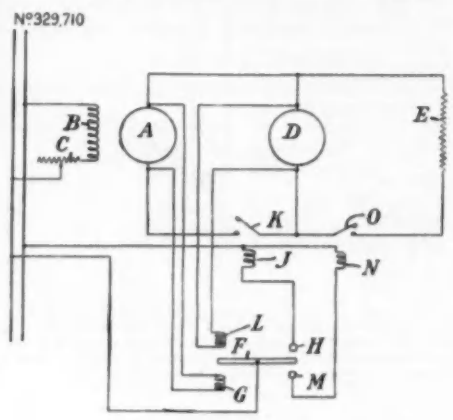


substantially helical grooves B and C are provided in the wall of the piston head D and in the throat E. Either the head alone or the throat alone can be provided with such passages. The combustion chamber also serves as a valve chamber accommodating two poppet valves, one valve being shown at F.—*May 29th*, 1930.

DYNAMOS AND MOTORS.

329,710. February 26th, 1929.—SYSTEMS OF ELECTRIC MOTOR CONTROL, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2, and Frederick Henry Harris, of 15, Manor-road, Rugby, Warwickshire.

This invention relates more particularly to the control of motors used for driving the various motions of a crane or similar apparatus, where regenerative lowering and electrical braking are required and having a Ward Leonard scheme of control. In the diagram only the circuits relative to the invention are shown. The usual Ward Leonard control arrangements will be required, but they are omitted from the diagram for the sake of clearness. A represents the generator, which is driven by a prime mover, such as a steam or oil engine, and excited from a supply circuit by a field winding B having a variable resistance C. The generator supplies current to a motor D, which may be used for driving any of the various motions of a crane, excavator or other apparatus. In order to absorb the energy generated by this motor when braking or when it is being driven by the load, a bank of resistances E is provided and the circuits of the motor are controlled by means of a balanced voltage relay F. The position of this relay is determined by the relative voltages of the generator and motor. When the voltage of the generator exceeds that of the motor, coil G of the relay operates and causes the relay to engage the contact H. That energises coil J and causes the switch K to close, thereby connecting the motor in circuit with the generator. If, on the other hand, the motor voltage exceeds that of the generator, the coil

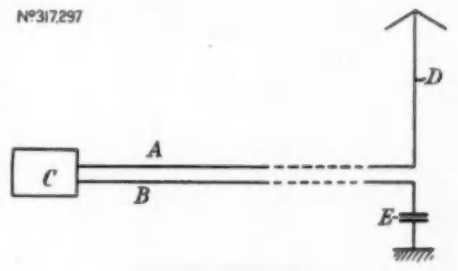


L operates the relay, causing it to engage the contact M and energise the operating coil N of switch O, thereby connecting the motor in circuit with the resistances E. The relay F may be made sensitive to operate on a very small difference in voltage across the coils G and L, this difference being only due to the drop in voltage of the cables supplying the motor.—*May 26th*, 1930.

TELEGRAPHS AND TELEPHONES.

317,297. August 12th, 1929.—CIRCUIT ARRANGEMENTS FOR CONNECTING AN AERIAL OR OTHER LOAD TO A HIGH-FREQUENCY SOURCE, Telefunken Gesellschaft für drahtlose Telegraphie m.b.H., of 12–13, Hallesches Ufer, Berlin.

When an aerial or other energy consuming device is connected to a very high-frequency source it is necessary to adjust the wave resistance of the feeder employed so as to equal the effective terminal resistance, *e.g.*, the radiation resistance in the case of an aerial, in order that transfer of energy may occur without considerable loss. When, however, the losses in the feeder are low, such exact adjustment is unnecessary. The principal object of the invention is to provide an arrangement, which is simpler than that ordinarily employed and is suitable for such cases in which the losses are not high, or in which the frequency

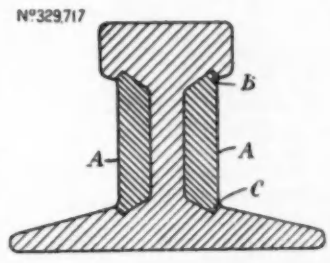


is not unduly high and generally when the requirements are not too stringent. According to the invention a double conductor system is employed as the feeder and the aerial, or other terminal device which acts as an impedance, is connected to one of the two conductors, the other conductor being connected to earth through an impedance, which is equal to the aerial impedance. A, B are the conductors of the double conductor system and serve to connect a transmitter C to an aerial system, the aerial being connected to the conductor A, the conductor B being connected to earth through a capacity E which is equal to the aerial capacity. It will be seen that this arrangement is symmetrical and that the radiation of the feeder is neutralised, thereby making it possible to fix the position of the transmitter building without being bound by the necessity of obtaining the most favourable radiation conditions.—*May 29th*, 1930.

TRAMWAYS AND RAILWAYS.

329,717. February 26th, 1929.—CONDUCTOR RAIL OF INCREASED ELECTRICAL CONDUCTIVITY, *Charles Rudolph Altenhein, of 14, Park-lane, Sheffield.*

The conductivity of a rail used for current collection is increased in accordance with this invention by providing strips A of highly conductive material. The strips have projections

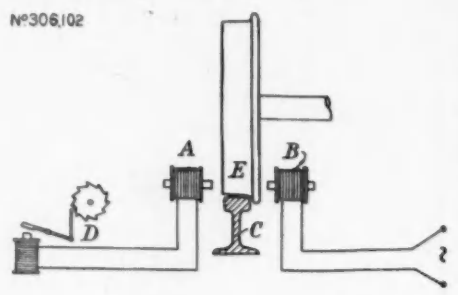


B and C which fit into grooves in the rail, and the strips are pressed or rolled into the grooves so as to make firm contact with the rail. The sectional area of the strips can be varied to suit the amount of current which the rail has to deal with.—*May 26th*, 1930.

306,102. February 15th, 1929.—CURRENT IMPULSE PRODUCING DEVICE FOR USE ON RAILWAYS, Allgemeine Elektricitäts-Gesellschaft, of 2–4, Friedrich Karl-Ufer, Berlin, N.W. 40, Germany.

In connection with devices to ensure the safety of railway travelling, conditions arise when it is desirable to know exactly how many axles have passed certain points. The device for producing the current impulse that can be used for the purpose

must, therefore, count all the axles singly, independently of whether the train is travelling at a high speed or very slowly. According to the invention two coils A and B are arranged on opposite sides of the rail C. The coil A is connected

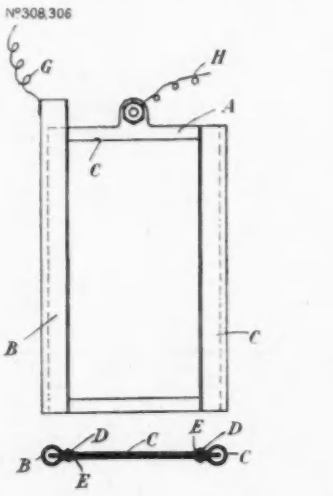


to the magnet coil of a counting mechanism D, whilst the coil B is fed with alternating current. Thus, when a wheel, as indicated at E, passes through the gap between the coils A and B a strong inductive impulse will be received by the coil A and will operate the counting mechanism D.—*May 15th*, 1930.

MISCELLANEOUS.

308,306. March 8th, 1929.—DRY METAL RECTIFIER CELLS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

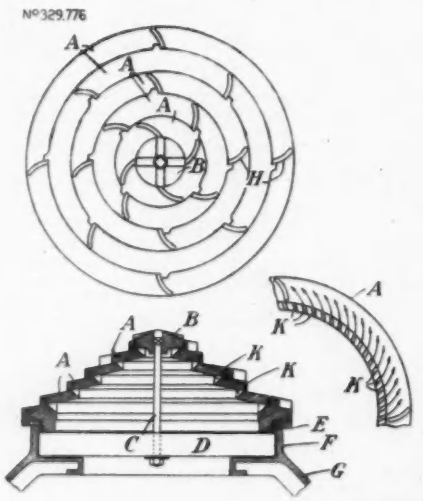
A dry metal rectifier constructed in accordance with this invention can have comparatively large dimensions with a comparatively thin copper core, so that it is suitable for the rectification of currents of considerable strength. A copper plate A is first coated on both sides with a layer of cuprous oxide, for example, by heating in an atmosphere containing oxygen. The sides of the plate are then each covered with a spring metal strip B and C, consisting of a good conducting metal, such as, for example, copper, or of a good conducting alloy. The plate A, with its edges covered by templates, is sprayed on both



sides with liquid zinc in such manner that on each side of the cuprous oxide layer a thin coating C of metallic zinc is formed, which is gradually strengthened towards the edges D of the metallic strips B and C and forms a metallic accumulation E under the edges D of such strength that the metal strips B, C are mechanically firmly fixed to the electrode plate A. At the same time this metallic accumulation, on account of its comparatively small resistance, forms an excellent current-conducting connection between the metal strips and the zinc layer C. The current supply is provided through two wires G and H. In consequence of the valve effect exerted at the point of connection between the copper core and the oxide layer, only the one-half wave of the alternating current is allowed to pass, while the other is suppressed.—*May 29th*, 1930.

329,776. April 9th, 1929.—GRATES FOR GAS PRODUCERS, *Gibbons Brothers, Ltd., of Dibdale Works, Dudley, Worcester.*

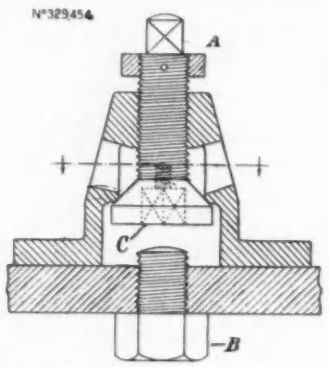
This invention relates to conical grates for gas producers.



The grate illustrated is a rotary conical grate and consists of superimposed concentric rings A of continuously increasing diameter, and a securing or cover ring B. Each ring rests on a flange on the ring below it. A central bolt C fastens the cover ring B and, consequently, rings A to a ring D adapted to engage with a flange E on the flange F of the frame G, which supports the grate. To facilitate cleaning and prevent particles of ash from assembling on rotation of the grate, ribs H are provided on each ring A and inclined to the radii of the grate. Numerous small orifices K give a rotary direction to the jet. The orifices are formed between each upper ring and the ring below it. This construction of orifice allows the air jet to pass unrestricted and issue uniformly.—*May 29th*, 1930.

329,454. April 2nd, 1929.—VALVES, C. E. Jones, Victory Works, East-parade, Bradford.

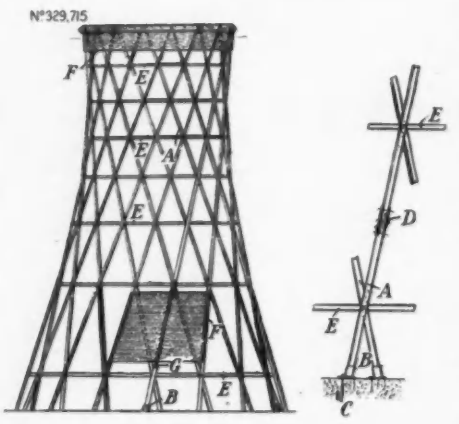
This invention relates to improvements in valves, and the object is to provide a valve of simple and inexpensive construction which is adapted to close an opening, in such manner that the valve may be opened and closed from either side of the plating or the like, in which the opening is made; for example, when the opening is in the shell plating of double-bottom ballast tanks, bilges and the like, so that it may be opened and closed from the outside, when the ship is in the dry dock, and from the bilge side or from the inside of the ballast tanks when these are empty. Where the invention is applied to the openings in the ship, shell plating as described, it is fitted, in addition to the plug which, in existing practice, is employed to close the



opening from the outside, in which case the openings are internally screw-threaded and the plugs screwed therein from the outside, the joint being made by a jointing washer interposed between the head of the plug and the plating. The invention is specially intended for ships carrying fuel oil in the double bottom tanks, in which case the removal of the wrong plug may mean a considerable loss of oil, owing to the difficulty of replacing the plug; in such cases the invention provides a ready means for closing the openings, either from inside or outside, also for closing a drainage opening, the plug of which may, by inadvertence, not have been fitted in the case of a ship leaving dry dock. The valve is opened in the normal manner, from the outside, by a key on the squared end of the stem A. If it is desired to open or close it from the inside, the stud B in the plating is removed and a key used in the recess C.—*May 22nd*, 1930.

329,715. February 26th, 1929.—WATER COOLING TOWERS, L. G. Mouchel and Partners, Ltd., and Marcel Ernest Gerard, both of 36–38, Victoria-street, Westminster, London, S.W. 1.

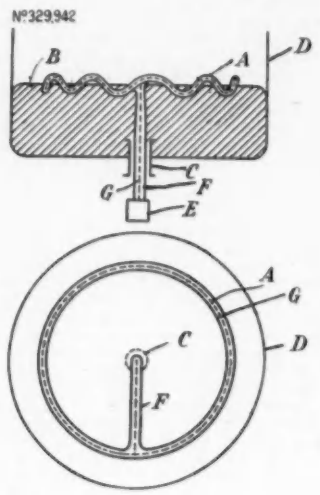
According to this invention, hyperboloidal water cooling towers are built of timber. Timber posts A are erected alternately on each side of the periphery of the base circle of the structure, the lower ends of the posts fitting into metal shoes B, which are securely anchored in a concrete foundation by holding-down bolts C. The posts may, if desired, be made in two or more parts connected together by a scarf joint D. The posts are erected at an angle to the horizontal ground level



and each post crosses other posts in several places, each place in a different horizontal plane. A corresponding number of polygonal rolled steel channel or other sections E of varying diameters, as required, are disposed inside the framework in the horizontal planes and at each crossing are fastened to the two posts by means of bolts passing through the posts and through the channel sections. The steel sections may, when convenient, be replaced by timber pieces. The tower is completed by nailing lengths of 1in. boarding F to adjacent posts to cover the space intermediate the posts, and the adjacent ends of the boarding lengths may be covered by cover stripe G fixed along the length of the posts.—*November 26th*, 1930.

329,942. October 15th, 1929.—ARRANGEMENT FOR IGNITING A MERCURY VAPOUR ARC, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

This invention relates to an arrangement for exciting and igniting the arc in metal vapour apparatus of the kind wherein a high positive voltage is applied to a conductor surrounded by a solid dielectric. The invention aims at providing a construction of the foregoing kind in which the conductor is of such a form that several portions of it will always assume a position favourable for the ignition of the arc even if the level of the mercury within which the conductor is arranged, should move. An undulating glass tube A filled with mercury is closed to form a ring, the median plane of which coincides with the mercury level B. A glass tube projects through the gland C and the bottom of the container D. One end of the glass tube merges into the igniting ring A and the other end carries the terminal E through which the mercury filling G of the tube F is conductively connected with the mercury core of the ignition ring A. The ignition of the arc is initiated by applying a high voltage to the terminal E. In consequence of its undulating form, the conductor G



projects through the mercury level at numerous places, so that even if the mercury level moves, there will always be several portions of the conductor which assume a position favourable for the ignition.—*May 29th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Summer Meeting at Bristol (conclusion).

MONDAY, JULY 7TH.

ROYAL INSTITUTION.—21, Albemarle-street, W. 1. General Meeting. 5 p.m.

TUESDAY TO SATURDAY, JULY 8TH TO 12TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Manchester.

WEDNESDAY TO FRIDAY, JULY 9TH TO 11TH.

BRITISH WATERWORKS ASSOCIATION.—Nineteenth Annual Meeting at Liverpool.

WEDNESDAY, JULY 16TH.

MANCHESTER ASSOCIATION OF ENGINEERS.—Visit to the Burnage Works of Hans Renold, Ltd. Assemble at the works at 2.30 p.m.

WEDNESDAY TO WEDNESDAY, SEPTEMBER 3RD TO 10TH.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—Bristol meeting. The presidential address, by Professor F. O. Bower, will deal with "Size and Form in Plants." Evening discourses will be given by Professor E. V. Appleton, F.R.S., on "Wireless Echoes," and by Dr. R. E. Slade on "The Nitrogen Industry and our Food Supply." Evening receptions and excursions to points of scientific interest, works, &c., in the locality will be arranged.

THURSDAY TO SUNDAY, SEPTEMBER 4TH TO 7TH.

INTERNATIONAL CONGRESS OF CONSULTING ENGINEERS.—Fifth Congress at Vienna.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

BROWETT, LINDLEY AND CO., Ltd., engineers, Sandon Works, Patricroft, ask us to announce that they have purchased the whole of the patterns, drawings, goodwill and trade name of Bumsted and Chandler, Ltd., Cannock Chase Engine Works, Hednesford, South Staffs., and that they are therefore in a position to supply spare parts, &c., for any of the productions of the latter firm.

LODGE-COTTRELL, Ltd., asks us to announce that it has changed the address of its office from 51, Charles-street, to George-street (Parade), Birmingham, and requests that in future all communications to its head office should be addressed to the latter address. Its telephone numbers and telegraphic address remain unchanged, viz.:—Telephones, Birmingham Central 3807, Birmingham Central 7387; and telegrams, "Lodcotlim, Birmingham."

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received from H.M. Office of Works an order for Mazda gas-filled and vacuum lamps to be supplied during the period ending May 31st, 1931.

THE HYDRAULIC ENGINEERING COMPANY, Ltd., of Chester, has received an order from the Great Western Railway Company for two movable hydraulic coal hoists and traversers for Queen Alexandra Dock, Cardiff.

THE BRITISH REMA MANUFACTURING COMPANY, Ltd., Halifax, is building for the North Metropolitan Power Station Company, Ltd., London, for installation in the Brimsdown Power Station, one British Rema patented ring-roll type pulverising mill fitted with the company's vacuum system of classification. The plant will have a guaranteed output of 12 tons per hour of coal to a fineness of 80 per cent. through a 200 by 200 mesh sieve and is to be capable of handling coal having a moisture content up to 18 per cent.